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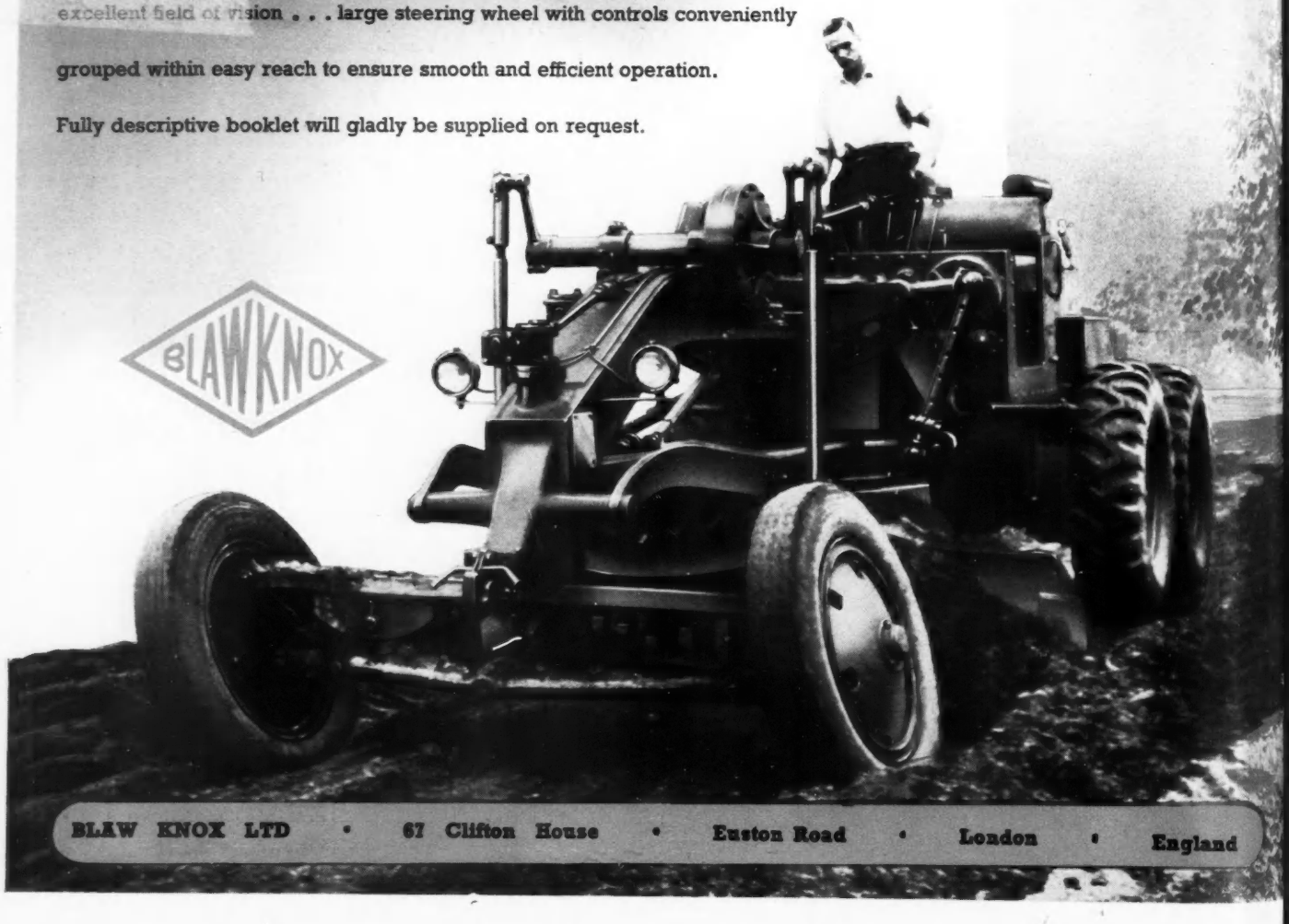

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Nationalisation of the Steel Industry

On Thursday of last week, September 14th, the Minister of Supply, Mr. Strauss, announced in the House of Commons the Government's intention to proceed immediately with the nationalisation of the iron and steel industry. He recalled that the Iron and Steel Act, passed in the last Parliament, provided for an Iron and Steel Corporation of Great Britain, consisting of a chairman and not less than six nor more than ten other members, none of whom should be appointed before October 1, 1950. The Government intended, the Minister said, that the appointments should be made on Monday, October 2nd, and the following had intimated their willingness to serve: chairman, Mr. S. J. L. Hardie, chairman of the British Oxygen Company, Ltd., and vice-chairman of Metal Industries, Ltd.; vice-chairman, Sir John Green, director of Thos. Firth and John Brown, Ltd., and chairman of the Central Conference of the Engineering and Allied Employers National Federation; full-time members, Sir Vaughan Berry, British delegate to the International Authority for the Ruhr, General Sir James Steele, Adjutant-General to the Forces, and Mr. W. H. Stokes, an official of the Amalgamated Engineering Union and chairman of the Midland Regional Board for Industry. Part-time members, Mr. J. W. Garton, chairman of Brown Bayley's Steel Works, Ltd., and managing director of the Hoffman Manufacturing Company, Ltd., and Mr. R. A. Maclean, chairman of A. F. Stoddard and Co., Ltd., and a director of Scottish Industrial Estates. Mr. Strauss added that the securities of the companies named in the Third Schedule to the Act would vest in the Corporation on January 1, 1951, or as soon as practicable thereafter. When the Corporation was set up, he proposed to consult its members about the earliest convenient date and would then make a further announcement. On Tuesday morning it was stated that Mr. Maclean had expressed his inability to serve as a member of the Corporation. On the same day there was debated in the House of Commons a motion, tabled by the Opposition, regretting the Government's decision to bring the Steel Nationalisation Act into immediate operation. This motion, however, was negatived by 306 votes to 300.

F.B.I. Statement on British Railways

The Federation of British Industries has forwarded to the Minister of Transport a memorandum which it has prepared on the strategic value and under-utilisation of the country's railway system. It claims that there is much evidence that the capacity of the railway system generally appears to be a good deal higher than is necessary to absorb peak demands in a normal peacetime economy. While in peacetime there is surplus capacity on the railways, yet in wartime the system as a whole is heavily loaded. There is thus a margin of surplus capacity which must no doubt be retained for emergency uses, but which is idle or under-used in peacetime. Normally, the Federation says, the burden of maintaining this surplus is borne by current transport charges. Hence a proportion of expenses necessarily incurred for defence purposes becomes a charge upon transport costs. A proposal made in the statement is that an independent survey of present transport facilities, including all fixed installations, rolling stock and equipment, should be undertaken. Such an inquiry should take account of the plans of the British Transport Commission for future integration of all public transport, and of the opinions of industrial, commercial and other transport users about their likely future needs. This survey would reveal what capacity is surplus to probable future requirements. The Defence and Supply Departments should be invited to say how much of the surplus or under-used capacity must be retained for emergency purposes. The cost of maintenance should then become a charge on the Defence Estimates, with a suitable apportionment between the different services and departments. But the Transport Commission would retain the responsibility for maintaining such capacity, a payment being made to it for the purpose from defence funds. Capacity and facilities not required either for civil or military needs should be considered redundant and dismantled or allowed to fall into disuse. Appropriate alterations should then be made in the capital structure of railway finances. The F.B.I. considers that the gap between capacity and requirements for normal peacetime purposes is steadily widening, a trend which is unlikely to be reversed. It asserts, therefore, that there is good reason for prompt action before the situation becomes still worse. The statement adds that a further reason for urgent action is that charges schemes of a long-term character are now under consideration. It would be wrong to include in those schemes any cost properly chargeable to the considerations outlined above.

Building Week at Leeds

The Ministry of Works Building Week, which was held at Hunslet Moor, Leeds, from September 11th to 16th, although generally similar to the Building Week held last year at Tunbridge Wells, was the largest exhibition of its kind ever held in this country. Displays by Government departments, various Institutions and the building industry, were arranged in three large pavilions, and there was a demonstration area, where some fifty-four manufacturers exhibited items of modern building plant. Films on building topics were shown daily, and various lectures were delivered by eminent authorities during the course of the week. Both old and new building materials were placed in juxtaposition at the entrance of the exhibition to catch the eye of the visitor. The entrance itself was a brick archway, inside which was the exhibition "feature," a 50ft mast of prestressed concrete. The mast was cast in sections and erected on the site. The main aims behind the building week are to promote greater efficiency in the industry and to attract apprentices to careers in building craftsmanship. Thus, one of the pavilions contained displays of work and craftsmanship by apprentices and students, and the Ministry of Works' exhibit, "Modern Site Organisation." Other Ministry of Works exhibits gave guides to greater efficiency in the subjects of steel economy, plumbing, thermal insulation and the applications of the Codes of Practice. The Building Research Station of the D.S.I.R. displayed two aspects of their work. One of these stressed the effect of prolonged exposure to the local industrial atmosphere of various types of concrete wall surface finishes, and emphasised the need for consideration at the design stage of the effect of weathering on the appearance of a building. The other illustrated the large-scale experiments which the Building Research Station is carrying out on house heating.

The Gas Council's Research Committee

One of the major duties entrusted to the Gas Council, as the central advisory, co-ordinating and financial body of the British gas industry, is the organisation and conduct of research. The Council has now announced that, to assist it in the discharge of this function, it has set up a research committee to consist of three eminent men of science not engaged in the industry, three members of the Council, the President for the time being of the Institution of Gas Engineers, the Livesey Professor for the time being at Leeds University, and the directors of the Research Stations—probably three—which it is intended to establish. The chairman of this research committee will be the chairman of the Gas Council, Sir Edgar Sylvester. The two scientific members who have agreed to join the committee are Sir Robert Robinson, O.M., F.R.S., and Sir Cyril Hinshelwood, F.R.S. Sir Robert Robinson has been Waynflete Professor of Chemistry at Oxford University since 1930 and President of the Royal Society since 1945. He was President of the Chemical Society from 1939 to 1941, and in 1947 was awarded the Nobel Prize for Chemistry. Sir Cyril Hinshelwood has been Dr. Lee's Professor of Chemistry at Oxford since 1937, and he was President of the Chemical Society from 1946 to 1948. The three members of the Gas Council who will serve on the committee are Mr. E. Crowther, chairman of the Northern Gas Board; Dr. R. S. Edwards, chairman of the North-Eastern Gas Board, and Mr. W. K. Hutchison, chairman of the South-Eastern Gas Board. The President of the Institution of Gas Engineers for the current year is Mr. F. M. Birks, deputy chairman of the North Thames Gas Board, and Professor A. L. Roberts, F.R.I.C., is the Livesey Professor at Leeds University. The Gas Council says that the existing laboratories of the North Thames Gas Board have been recognised as the nucleus of the London Research Station, and Dr. H. Hollings, F.R.I.C., who has for some years been controller of those laboratories, has joined the research committee as director-designate of the station. The committee will be responsible for advising the Gas Council on all matters connected with research, for drawing up programmes of research and for reviewing progress from time to time.

Productivity in Grey Ironfoundries

Early this year a representative team from the British grey ironfounding industry visited the U.S.A., at the suggestion of the Anglo-American Council on Productivity. The team, which was led by Mr. S. H. Russell, has now presented a unanimous and comprehensive report. Before leaving for America, the team visited twenty-nine jobbing foundries in this country so that a general background could be obtained for its investigations in the U.S.A., where twenty-four of the 2500 foundries in that country were inspected. The report does not overlook the fact that the British ironfounding industry has increased its output year by year since 1945, and has begun to effect many real improvements, but the team discovered that American foundries produce far more per man than the British. Many reasons are advanced for greater productivity in the U.S.A. and some of them are elaborated in the report. It is noted, for instance, that management in American foundries is highly efficient and particularly receptive to new ideas, an attitude which, the team suggests, undoubtedly encourages members of the staff and produces numerous suggestions for improving output. The members of the team were also surprised to find in the U.S.A. that even close competitors are readily shown the production methods of their rivals, and that a free and full description of all processes is available. Among the many other matters touched upon in the report are the greater use of power, mechanical aids and unskilled labour. In some jobbing foundries in Britain, it is pointed out, the skilled moulder often spends not more than half his time in the actual production of moulds, the other half being occupied in general labouring and kindred duties. In American foundries, the report says, it is realised that such work can be done more expeditiously and economically by lower-rated labour, with mechanical appliances and adequate power. Research, it is added, has cut out all costly and unnecessary handling. The report is published by the Anglo-American Council on Productivity, 21, Tothill Street, London, S.W.1, price three shillings and sixpence.

Transcontinental Railway, Australia

By G. H. PAULIN, M.I.Mech.E., M.I.Mar.E., M.I.Loco.E.

A LITTLE time ago the Australian Commonwealth Minister of Immigration, Mr. Calwell,* reported that he expected, during the eighteen months beginning January, 1949, that 250,000 immigrants would enter Australia. This addition to Australia's population is considerable and for many the port of Fremantle will probably be their first sight of the island continent. The sea distance from Fremantle to, say, Melbourne, in the Eastern part of the continent, is 1853 miles, and probably few of this large number of people know that it is possible to make this portion of their journey by rail. In fact, it is probable that only a very small percentage of travellers making their first visit to Australia know of the existence of the transcontinental railway. This is rather a pity as the journey by rail across the fantastic central desert can be of intense interest. There is perhaps nothing quite like it anywhere else in the world.

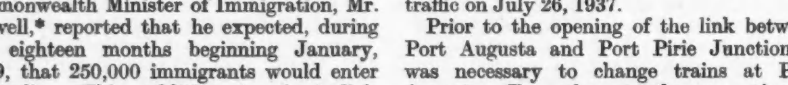


FIG. 1—TRANS-AUSTRALIAN RAILWAY

Australia is considered to be, geologically, the oldest dry land on this earth, and to those who desire to obtain some adequate conception of the interior of the continent, no experience is more helpful than a journey over the Trans-Australian Railway, which links Western Australia with Adelaide and, through that fine city, with all Eastern Australia. Distinguished people from many countries have travelled overland on this route to learn at first-hand the character of the country of the interior, and they have been fascinated and awed by what they have seen. Many have marvelled at the courage and the fortitude of the early explorers who crossed this stark, waterless region. Some great men made these pioneer crossings, the greatest being John Forrest, who later became Lord Forrest, and a very prominent figure in the development of Western Australia.

The Western terminal of the Trans-Australian Railway (Fig. 1) is at Kalgoorlie (population 27,000), in Western Australia. For some considerable time the Eastern terminal was Port Augusta (population 4500) at the head of Spencer's Gulf, in South Australia. The distance between these two places is 1051 miles. Work was begun on the construction of the line on September 14, 1912, working Westward from Port Augusta. On February 13, 1913, construction eastward began from Kalgoorlie. The rails were joined at the boundary between Western Australia and South Australia, on October 17, 1917. An extension of the line from Port Augusta to Port Pirie Junction—and Peterborough, on 3ft 6in gauge. The opening of the link, Port Augusta-Port Pirie Junction, has eliminated the change of trains at the former and the much longer journey (119 miles) over the narrow gauge part of the system. A new mixed gauge terminal, with passenger transfer station, has been provided at Port Pirie Junction.

The total length of the Trans-Australian Railway is, then, 1108 miles. The gauge is the standard 4ft 8½in.

The link between Perth, the charming capital city of Western Australia, and Kalgoorlie, the western terminal of the Trans-Australian Railway, is 380 miles in length—3ft 6in gauge. From Perth to Adelaide the total distance is 1622 miles, with change of trains (and gauge) at Kalgoorlie and Port Pirie Junction. At the latter point the gauge becomes 5ft 3in and carries on, through Adelaide and Melbourne, to Albury on the border of Victoria and New South Wales—a further 807 miles.

At this point the gauge again becomes 4ft 8½in, and this extends north through New South Wales to Brisbane, the capital city of Queensland, a further distance of 1012 miles.

It is therefore possible, through the existence of the Trans-Australian Railway, to travel by rail from Perth to Brisbane, a total distance of 3307 miles.

The traveller from Britain, disembarking at Fremantle and completing the journey to, say, Adelaide, by rail, would cross Australia West to East. Transcontinental trains leave Perth on Mondays, Wednesdays and Fridays, at 8.10 p.m., arriving Adelaide on Thursdays, Saturdays and Mondays, at 1.15 p.m.

In the passage across the continent clocks are changed three times. Perth time applies as far as Kitchener (547 miles); Central time is used as far as Barton (1055 miles); Adelaide time as far as Serviceton (1818 miles). Here Eastern Standard Time applies and holds for the remainder of the distance to Brisbane. Eastern Standard Time is two hours ahead of Perth time and thirty minutes ahead of Adelaide time. Central time is forty-five minutes ahead of Perth time.

The western terminal, Kalgoorlie, 1240ft above sea-level, is the highest station on the "Trans line," as it is called locally. The lowest point is Port Pirie Junction—18ft above sea-level.

From Kalgoorlie the line begins on a short rising gradient of 1 in 254 followed by one mile of 1 in 80. At the top of this 1 in 80 is the highest point on the line. Eastward there is a fall to 658ft at Kitchener, 167 miles from Kalgoorlie, after which there is slightly undulating country as far as Pimba, 938 miles further east. From here the general level falls to 21ft at Port Augusta.

From the railwayman's point of view the most notable feature of the railway is the Nullarbor Plain (native for "no tree"). The plain has an area of approximately 100,000 square miles. The geology of this strange region is little known, but it is clear that at one time the whole area was the sea-bed.

The railway runs for over 400 miles across the plain, and for 315¼ miles is without curvature—the longest stretch of straight track in the world. Fig. 2 shows a view taken from the front of the engine. In the 1108 miles between Kalgoorlie and Port Pirie Junction there is not one permanent stream of fresh water. The older Admiralty charts of Southern Australia contain notes (no doubt added originally for the benefit of seamen navigating in this region), which state "Great Victoria Desert. Entirely destitute of water." Another note reads "Eucla to head of Bight is entirely destitute of water"—grim commentary but fair.

The whole aspect of the plain is weird and unreal—an ocean of red, sandy soil.

FIG. 2—NULLARBOR PLAIN

* This article was written before the recent change in the Australian Commonwealth Government.

It is nearly always windy. The traveller will probably encounter perhaps a 20 m.p.h. breeze. Here and there are seen local dust-storms. Over most of the horizon red dust clouds rise like smoke from a forest fire. There is no scenic grandeur but the unusual, the mysterious, the weird, strike the senses. The sunsets can be beautiful in the extreme. The western sky becomes splashed with a surging riot of colour—first some delicate tones, the yellows and golds, but as the beams of light fall nearer the horizon the reds and deep reds predominate—the whole forming an unforgettable picture. No doubt the dust-laden atmosphere has an influence and sets up unusual conditions helpful to the formation of these orgies of colour.

In the country 300 miles west of Port Augusta large sheep stations, carrying something like one million or more sheep, are established. The average rainfall in this area is between 7in and 8in and the district is very different from the region of the plain. Tarcoola is the largest settlement between Kalgoorlie and Port Augusta. Before the building of the railway communication between Tarcoola and Port Augusta—a distance of 257 miles—was by coach drawn by mule teams.

It is the aim of the Commonwealth railway authorities to make the transcontinental railway journey as comfortable as possible. They go far to providing the amenities of a modern hotel. Sleeping compartments are comfortable and lounge cars spacious and restful. Hot and cold baths are available. Lounge and dining-cars are air-conditioned, and the equipment of the former includes a piano, easy chairs, deep lounges, writing desks and tables. A brief summary of the more important news of the day is made available in the lounge car en route. The meals on the dining-car are of a very high standard and the traveller straight from ten years of British austerity finds some considerable difficulty in exercising restraint.

Fig. 4 shows a complete express train standing at Cook, the mid-plain locomotive divisional point. It will be observed that some enthusiastic arborealist has planted a tree—a peppercorn—the only tree which has managed to survive in the conditions.

Fig. 3 shows the type of locomotive used for Trans-Australian line expresses.

The class is "C.36" modified.

Cylinders	Two
Bore	23in
Stroke	26in
Coupled wheels	5ft 9in dia.
Boiler pressure	180 lb/square inch
Heating surface, firebox	190 square feet
Tubes	1,765 square feet
Total	1,955 square feet
Superheater	650 square feet
Grate area	30·5 square feet
Wheelbase:	
Rigid	14ft
Engine	26ft 3½in
Tender	32ft 9in
Overall	70ft 11½in
Weight:	
Engine only (roadworthy)	87 tons 10 cwt
Engine only (empty)	68 tons 17 cwt.
Tender (roadworthy)	118 tons 17 cwt.
Tender (empty)	47 tons
Total engine and tender in working order	206 tons 7 cwt.
Tractive effort, 85 per cent boiler pressure	30,500 lb
Coal capacity of tender	17 tons 10 cwt. (sufficient for 520 miles)
Water	12,180 galls. (sufficient for 184 miles)

This class of locomotive is designed for a speed of 60 m.p.h. with a trailing load of 440 tons, on tangent track. The design is basically that of the well-known "C.36" class, which has operated so successfully for many years on the New South Wales Government Railways. Design and manufacture is entirely Australian and the locomotives with which we had personal contact were built by Walkers, Maryborough, Queensland. Grease lubrication is employed in axle-boxes, coupling and connecting-rods. The cab is well arranged, with back plate and canvas curtains, which are designed to provide additional protection from the very cold winds which are experienced at times in this region. Westinghouse air brakes are used and all controls arranged on the left-hand side. The firehole door is air operated, through the medium of a pedal located conveniently where the fireman normally places his right foot. Electric headlight and other lighting improves night running conditions very considerably.

The illustration of locomotive "C.63" shows this engine as originally delivered, with the headlight directly in front of the funnel. In this position complex down-draughts were set up. With early cut-off, smoke and steam obscured the driver's view. The headlight was later moved to a position on the smokebox door. Draft wings were also added along the top of the smoke box. The illustration of engine "C.66," Fig. 4, shows these alterations.

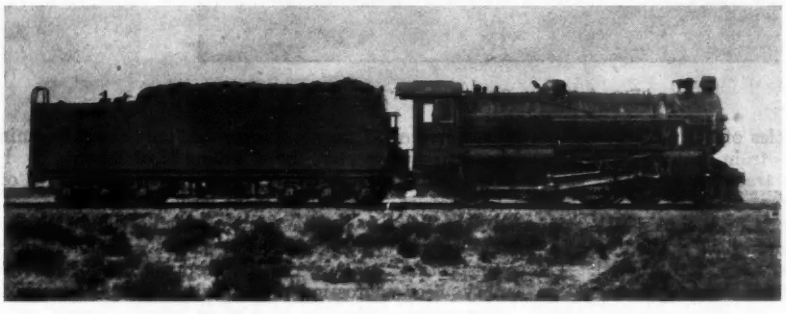


FIG. 3—MODIFIED "C36" CLASS EXPRESS LOCOMOTIVE

The locomotives handling these trans-continental passenger trains run right through from terminal to terminal (1051 miles). One complete journey each way is made per week, so that weekly locomotive miles are 2102. Enginemen operate for short sections of about 140 miles. From Kalgoorlie, the first crew work to Zanthus (127 miles) and occasionally through to Rawlinna (235 miles). The next set of men work to Forrest (about 156 miles); the next set the same. A similar distance is worked to Cook. Cook men work as far as Barton (86 miles) and Tarcoola men take over to Tarcoola (67 miles). This is convenient for the eastern end locomotive working. Tarcoola men work through to Pimba (134 miles), with Port Augusta men completing the final 113 miles. Servicing of locomotives is carried out at points en route, the locomotive leaving the train and proceeding to the locomotive depot for this purpose. At Cook, for example, facilities are provided for rapid coaling and for other service operations.

One of the problems involved in the operation of this railway is water supply. As mentioned earlier, there is not one permanent stream of fresh water in the 1108 miles' length of the line. Locomotive water is obtained from artesian wells and varies in quality—mostly bad. Special boiler blow down arrangements are provided and enginemen are held to rigid procedure in this connection. Each engine crew takes a sample of water from the boiler at the end of their section. These samples are sealed in metal containers and sent to the laboratory at locomotive headquarters in Port Augusta. Here analyses are carried out and reports circulated. In this way a close check is kept on drivers and in consequence on the condition of boiler water. The system seems to work reasonably. In a visit to the locomotive shops in Port Augusta the amount of boiler work in evidence did not appear excessive when the extremely difficult conditions of operation were appreciated.

Fig. 5 shows a typical water-tower and column at Wirramina.

The "metropolis" of the plain is Cook, the locomotive divisional point situated almost exactly midway between Kalgoorlie and Port Augusta. Fig. 6 shows Main Street—a busy centre!

The Commonwealth Railways Department operates its own stores to supply employees with meat, groceries, fruit, vegetables, clothing and general household goods. The main store is at Port Augusta, with branches at Tarcoola, Cook, Rawlinna and Parkeston. For those employees and staff located at other points on the line the Department provides an unusual amenity known as the "Tea and Sugar Train." This train traverses the line weekly in each direction and comprises all the features of a high-class store, including refrigerated cars, from which can be purchased fresh meat of all sorts. To those men and families located at remote and lonely points the "Tea and Sugar Train" is a boon. One of the features of Cook is the stockyard, with adjoining abbatoir and freezing house, and through these the railwaymen are able to obtain supplies which would otherwise be impossible.

Life in the desert can apparently be anything but monotonous. At Cook there are about twenty houses; the school, a recreation hall, railwaymens' hostel, the one-roomed station building and the locomotive depot. All about, in every direction, is desert. We wondered how people could exist in such conditions, and made the error of mentioning this to a locomotive official. "Exist," he said with considerable force. "Good God, I have been here ten years and like it." Apparently the desert air, in spite of the dust, is healthy. The hustle and frustration of large centres is non-existent. The life is one of relative simplicity and quiet. The sea-coast is only about seventy miles south and the local people seem to think nothing of motoring to the coast for a days' fishing or a camping holiday. Perhaps they have something there—at least, the men. One wonders what the women would say.

We visited one of the railwaymen's hostels. These buildings are of wood construction, but solidly and substantially built. The sleeping quarters are well arranged and comfortable. A kitchen, with equipment which might well be the envy of many

British housewives: bathrooms shining with chromium plate and a lounge with radio and easy chairs—and a fireplace—completed the amenities. Very different from the railway accommodation we knew in Southern Cross, Western Australia, half a century ago!

During our journey on this railway we made a surprising discovery. The train was "dry." This explained the generous gift, by a good friend in Kalgoorlie, of one dozen bottles of beer, placed on board just before the train left. Further on the journey the train had stopped to take locomotive water. We alighted to admire the riot of colour in the west—the sun was at a low angle. The light was glinting on myriad points on the ground. Closer inspection showed these points to be empty beer-bottles—thousands of them. The track was literally ballasted with beer-bottles! This matter was taken up seriously with the dining-car chief. If the train was "dry"—why these signs of revelry? It transpired that during the war the Trans-Australian Railway transported divisions of troops, Australian and American. It was evident that the train loadings included equipment other than military.

One of the features of this line is the friendliness of the people, and the relatively leisurely mode of travel—both of which will be appreciated by sensible travellers. We had been on the train only a few hours when an invitation was received from the conductor to proceed to the brake van—a commodious vehicle. On presenting ourselves in the van we found a group of railwaymen with a coloured illustration of the L.M.R. diesel-electric locomotive, "No. 10000"! Would we be good enough to tell the assembled company all about "No. 10000" and how it worked. It had got around somehow that we had been intimately connected with the design of "No. 10000," and the action of these good railwaymen showed very well how our relatives down under keep themselves extremely well informed as to what is going on in other parts of the world. To have to give, in the trackless heart of Australia, a short talk on diesel-electric locomotives was indeed a most unexpected experience.

An unusual and intriguing note appears on the official time-table—"Between Zanthus and Tarcoola trains may run ahead of times shown." This seems to be taken literally in the operation of trains. At one point in our journey we were 1½ hours early. It was mid-afternoon and again the locomotive tender was being filled. The wind had dropped, the sun was bright, and conditions right for a short stroll. The passengers did not waste the opportunity. The driver, after satisfying himself that all was well with his machine, held court on the front of the locomotive. Seated on the buffer beam, he was the centre of considerable interest and a number of ladies were included in the group. Cigarettes were passed and the light conversation, with laughter, had everybody in a good frame of mind. This, surely, is the right way to travel. As Tarcoola was reached only about five minutes early, the "killing" of about 1½ hours between this point and the location of the "party" meant very easy going.

By the courtesy of the then chief mechanical engineer—Mr. E. Adam—we were able to ride on the footplate for part of the crossing of the plain. At an hour when our vitality is always at its lowest ebb we dragged ourselves unwillingly from a comfortable bed. As we alighted heavily from the sleeping-coach a cock crowed—"the cock that is the trumpet to the morn." In the east a pale, sickly light—in our heart a doubt as to the wisdom of our action. It was early September, late winter, or perhaps the feeble beginnings of official spring. Cold—yes, but the wind had not yet arisen.

As we approached the front end of the train our spirits rose. There were the sounds the railwayman hears all over the world—the thud of coal-pick on a large lump; a sliding crunch and then the musical ring of shovel on firehole door. The singing, indrawn note of an injector; the low buzz of the lighting turbo-generator. And the smell—the characteristic smell of a warm steam locomotive—the same, north, south, east or west. The rosy light from the open firehole sent beams at an angle into the still somewhat dark outside. Smoke curled lazily up from the funnel and the scrape of the drivers' boots on the ballast could be heard as, smoky torch in hand, he had a final look round. This was all, to the senses, an immense satisfaction, and at the top of several steps to the footplate our spirits were normal again.

The driver, quite young—about thirty-two—got the train away nicely and in a very short time we were bowling along at a steady 40/45 m.p.h., with a full regulator and about 25 per cent cut-off. In spite of the 400 miles to 500 miles already covered, the fire was in good shape and steaming free. The fireman's work at this time was not arduous. Later, when the wind rose and came in from the north the firing rate was noticeably heavier. Cut-off was lengthened and two injectors were used at times. The "riding" of the engine was about the usual; plenty of noise, everything loose and "working" visibly. In fact, the driver complained that "the boiler was thrashing about in the frame." It wasn't. The movement was little different from the usual seen on "Royal Scots" and similar jobs—working, of course, at much higher speeds but on better track.

We could not but compare mentally the conditions of operation with a run made not long before on the "Royal Scot." On the Nullarbor one did not see a signal. The view ahead was of the two rails merging together on the dusty horizon. Not a suggestion of curvature for hour after hour. On the "Royal Scot" the time between the sighting of signals was something of the order of three minutes. From Euston to Glasgow, about the same distance as the length of Nullarbor Plain, the signals number about 300.

On the transcontinental, the distance between sections is about 45 miles. All sections are not staff sections, so in some locations there are quite considerable distances between crossing stations. In a number of places semaphores were erected when the line was built but the arms and associated gear have long ago been removed.

We did not make the full crossing of the plain and at Watson made our adieu to the engine crew. The approach of the luncheon hour and the wonderful meals served in

FIG. 4—TRAIN STANDING AT COOK

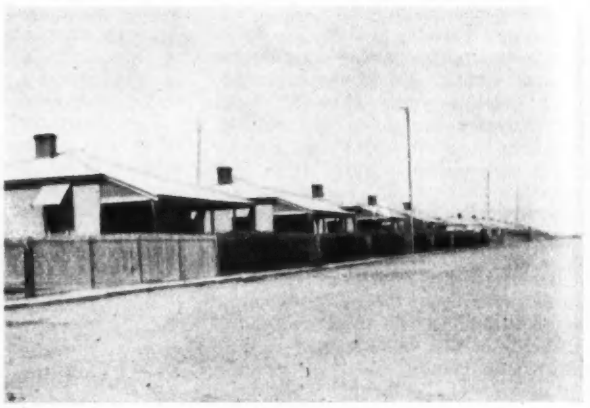


FIG. 6—MAIN STREET, COOK

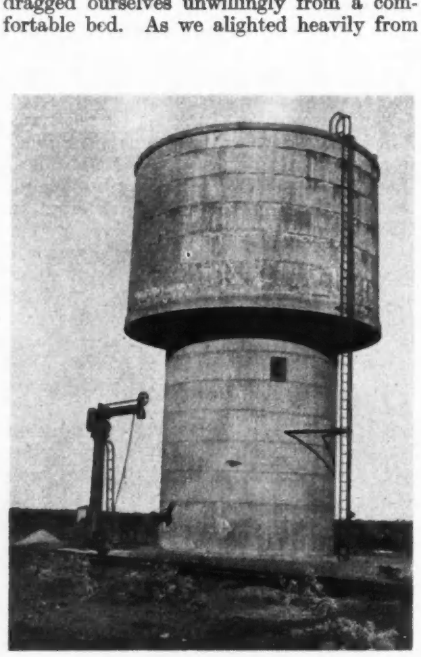


FIG. 5—WATER TOWER, WIRRAMINNA

the dining-car drew us unerringly back to the train.

Arrival at Port Augusta was made dead on time at 6.08 the next morning, after what was one of the most interesting rail journeys we have made. The route is not through mountain grandeur, as in the western portion of the Canadian Pacific. The interest of the Trans-Australian line is in the weird and the unusual. Not the least attractive aspect of the journey is the informal mode of making it. At stopping places one alights and strolls about. The driver, the fireman, the guard, the conductors, all seem to form part of the family party.

We are indebted to the officials of the Commonwealth Railways for the privileges extended to us and the courtesy which helped so much to make our recent crossing of Australia a very happy one.

The British Association

No. II—(*Continued from page 254, September 8th.*)

AT the opening meeting on Thursday, August 31st, Professor Andrew Robertson, President of Section G (Engineering), cordially welcomed a number of overseas visitors. He then presented his Address, after which the section split up into two sessions.

Session A

The paper presented to this session discussed "Bridge Engineering To-day and To-morrow," and being on the same subject as the Presidential Address, the President took the chair.

Dr. G. Roberts (Messrs. Freeman Fox and Partners, consulting engineers) discussed the factors which have influenced bridge building in the past and which would continue to do so in the future. He said the more important ones were the properties of materials available to the designer and the science underlying the designer's art. An equally important one was what he called the philosophy of design which embraced the human or personal decisions which the designer had to make. The quality of material to-day was far better than it was twenty years ago. Aluminium alloys one-third the weight of drawn steel wire were being used for structural work. The disadvantages of aluminium, however, were high cost and the fact that it was not weldable, but it was to be hoped that aluminium alloys would be developed which would have the properties of drawn wire in this respect. Then its lightness would make it an extremely useful material for suspension bridges. So far as he knew, the new weldable very high tensile steel had not yet been used for important structures, although he believed it was being used quite a lot for portable bridges. There was also the combination of two materials known as prestressed concrete in which concrete members were made in a factory; they were pierced with holes and were then transported to the site and the holes threaded with 10-ton wire which was stressed to 70 tons per square inch. The result was that the concrete would never crack under normal stress, and even if cracks appeared through overloading they disappeared when the load was removed.

He criticised the action of various committees in making slight variations from time to time in bridge design formulæ without making very much difference to the result, and said that the basis of bridge design had always been a mixture of science and sense, compacted as closely as possible. In the past there had been a scientific content which resulted in bridges being wasteful, but not unsafe. But when bridge designers became accustomed to the use of science, especially mathematical science, they would be able to design bridges more cheaply and safely. It seemed to him that in practice bridge designers relied more and more on the use of science without checking the assumptions to which they applied it.

Another philosophical approach to the general factor of safety problem was included in the so-called plastic method of design based on Professor Baker's experimental work at Cambridge, which was difficult to explain in a few words. Briefly, it was that the members of the structure were not each designed separately for a working stress. They were each regarded as a team and all the members of the team had to be fully stressed before the collapse of the whole structure occurred. This produced a surprising economy, for as each member became overstressed, it seemed to yield a little and pass on its load to its neighbour. It would greatly simplify the design of struts if a method of this sort could be devised.

With the development of drawn wire to replace chains, long span suspension bridges became not only feasible, but practicable and economical. A large number of clever mathematical analysts or engineers had applied their brains to the problem of economy of vertical stiffening. Analytical methods had been produced which, although laborious, gave an accurate idea of the combined effect of the cable on stiffening. On bridges of over 3500ft in length, the weight of cable was very considerable, and the horizontal component of the struts was so great that a very large force was required to deflect it from the catenary, so that in the ultimate limit it should be possible to do without any stiffening struts at all. In their search for economy, designers had reduced the stiffening girder from, perhaps, a 30ft deep strut to a 6ft deep plate girder, and abandoned their ideas of a definite width in relation to span for lateral stability, the lateral force being resisted by the spring of the cables. It was there that science might lead one astray. By going away from experience and relying on mathematics designers had unwittingly brought in another factor. Aerodynamic considerations entered into the design of the structure. Referring to the proposed Severn Bridge, he said that many experiments had been carried out on small models in a specially constructed wind tunnel. The results of those experiments had shown that longitudinal slots had such a stabilising effect, combined with stiffening truss girders instead of a solid plate, that the bridge could be regarded as entirely stable.

Mr. J. S. Wilson said he presumed that in the case of the proposed Severn Bridge provision had been made for variations of wind along the length of the bridge. He recalled that in the case of the Forth Bridge measurements had shown that the wind had different intensities along the various lengths of the bridge.

The author replied that precautions were being taken in this connection. On the next bridge up the River Severn—the Sharpness Railway Bridge—there had been installed instruments at four points at a height equal to that of the proposed structure. They had been specially designed to record simultaneously the direction, inclination and speed of the wind. Moreover, it was intended to do something that had not been done before. It was to accelerate the recording charts to 12in an hour so that gusts of very short duration could be fully recorded. In the normal recording instrument it was very difficult to see whether a gust had lasted for three minutes or three seconds. Therefore, more would be known about this matter in time and it would be possible to have a final check on the aerodynamic stability of the structure.

Session B

Professor G. W. O. Howe took the chair in Session B. Professor A. Tustin (Electrical Engineering Department, Birmingham University), in a paper on "Present Progress in Automatic Control Systems," said that the development of automatic machinery and of mechanisation, which had been characteristic of the last 150 years, was continuing more rapidly than ever. Most people believed it to be a good thing and to be likely, in the not too-distant future, to ensure a good life for mankind. Personally, he could not regard that result as certain. It seemed equally possible that advancing mechanisation might lead to the dissipation of the earth's limited resources in a joyless urban existence, to a blind proliferation of population, to intensified economic competition and to ever greater horrors of war. The aspect of the study of mechanisation which most urgently needed to be pressed forward was the study of its proper use. For better or for worse, the continuing development of automatic devices was one of the main forces which were shaping the world's future and presenting us with new problems, and it was desirable to understand the nature and the limitations of this development.

The chief purpose of his paper was to explain the principles of the particular class of automatic control that had become more important in recent years, viz., those controls which were error-actuated, and in which there had been marked progress during and since the war. Because in such an arrangement the error determined the control operation, and the control operation affected the error, there was a closed sequence of interdependence via these quantities, and they were also called "closed-sequence controls" and "servo systems" when they controlled mechanical movements.

Before discussing closed-sequence systems in general, Professor Tustin gave a detailed description of the automatic gun-layer as a particular example of an error-actuated or closed-sequence control system, this being a straightforward case of the replacement of human operators by a mechanism. He then dealt with a number of other recently developed automatic control devices and showed how the same essential elements occur in them all, viz., an error-detecting device, or power amplifier, a motor or some other means of varying the output, and some damping or "anti-hunting" device.

Modern boiler control was mentioned in order to show that several output quantities may be controlled in such a way as to keep them in certain fixed relationships. Because of error control none of these quantities could depart very much from the selected settings. It was possible to improve on this basic arrangement by introducing supplementary interconnections, in such a way that as the fuel valve opened the dampers were given a corresponding displacement. The right combination required very careful working out,

but it was possible to arrange that any given demand for steam resulted in the particular combination of fuel valve and damper openings which was considered to give the best combustion conditions.

The control of large astronomical telescopes was next mentioned, and it was pointed out that it is possible to drive a large telescope, the moving part of which may weigh hundreds of tons, on exactly the same principles as in the case of laying of guns, and to direct it on a particular star automatically. But a quite distinct type of control had been under development at Birmingham University, the purpose of which was to eliminate the blurring of the photographs of stars owing to the continual slight movements of the star imagines on the plate caused by varying atmospheric defraction. In this method of control, use was made of photo-electric cells to ensure that all the stars in the limited field to be photographed move together, thus giving sharp images after a long exposure. The essentially new feature in this type of control was the use of a rotating disc "scanner," which may be regarded as an error-measuring device appropriate in this case.

After giving a formidable list of the industrial problems to which closed-sequence control and regulating systems had been applied, Professor Tustin said there was scope for further applications of such controls in almost all industries. The steel industry, with its many needs for remote manipulation of masses of hot steel, might find application for remote control of position. The chemical industry was likely to extend the scope of automatic plant control in the direction of completely controlling all the conditions with reference to the continuous measurement of the quality of the product. This depended on the maintenance at many points of exact control of such quantities as temperatures, flow of liquids, pressure, proportion of mixtures and ultimately of chemical composition. Such a control apparatus would be something like a limited "one-purpose" brain continuously making the necessary combinations and calculations and deciding on the right combinations of action to be taken. It was possible to combine automatic control apparatus with the modern digital calculating machines which had recently been developed. There was, in fact, no limit to the scope and complexity of the arithmetical calculations which could be made every second, if need be, as part of the normal operation of such a control. The equipments, however, would be expensive and there might be few industrial situations which would justify them.

Another possibility which had recently been the subject of experiment was remote automatic control through telegraph or radio links. There was obviously little limit to the distance at which automatic control could be exercised because once the information had been turned into some form of radio signal it could be transmitted half way round the world, if need be, in less than a tenth of a second. The central supervisory control of the national electrical power system was one case for which it was not too fantastic to conceive of radio or telegraphic links bringing the essential measurements of load and the like to a central automatic control, which would almost instantly make the necessary computations and forecasts and send out the required signals, bringing about the optimum distribution of load between stations and forestalling anticipated shortages. Such things were technically possible if the great expense was justified, and possibly such developments might prove to be justified in some field at some future date.

After a discussion of the limitations of the human operator as a control element, the author stated that at first sight it might be thought that any of the automatic control systems he had mentioned could be made infinitely more and more accurate by simply increasing the amplification, so that a smaller error would suffice to provide the required variations of output. This would be the case if the response to error were instantaneous, but in practice time delays occur. If time delays occur between the error and the corrective action, the corrective action persists in the same direction after the error has been fully corrected, so that the error reverses and an error occurs in the opposite direction. If the amplification is more than a certain amount, each successive overshoot is greater than the preceding one and the system becomes unstable. It maintains itself in a state of oscillation, or "hunting," which increases in amplitude until some other factor limits further increase. The advances that have been made in recent years in the design of control systems have centred round this problem of increasing the accuracy of control by increasing the rate of output to error without producing "hunting."

It was therefore relevant to inquire why a power amplifier, such as an electric generator or a sequence of electric generators, cannot be made to have an instantaneous response; why, in other words, a voltage applied to the field winding of an electric generator cannot result in an instantaneous corresponding variation in the generator output current. The answer was, of course, that all electric circuits are inductive. Increased currents mean increased energy storage in the magnetic fields. If the currents and fluxes were increased instantly to new higher values, momentary power input of infinite value would have to be supplied from somewhere. The time delay was the reflection of the fact that this could not occur, and that the stored energy must be built up in order that the condition of increased output might be achieved.

This kind of consideration was not peculiar to electric generators; it was common to all known amplifiers of power. But it showed where the designer must look for fundamental improvements in the accuracy of control systems. The basic need was for power amplifiers which involved the minimum increase in stored energy for given changes in power output. Certain new types of multi-stage generator were much better in this respect than the conventional generator, and this was the real basis for the remarkable performance of many control systems recently developed.

Mathematics and Physics

The meeting of Section A (Mathematics and Physics) on Thursday, August 31st, was devoted to a discussion on high-energy particles and machines for their acceleration.

Professor R. E. Peierls (Department of Mathematical Physics, Birmingham University) said that recent advances in techniques have led to the construction of machines that can accelerate particles to energies of a few hundred million electron volts (MeV). The interest of such fast particles to the nuclear physicist resulted first of all from the fact that, whilst a good deal was known about the pieces of which atomic nuclei are built, little was known about the nature of the forces that hold them together. More could be learnt about the nature of these forces by studying collisions of such particles at high energies. It was likely that for this purpose the region of a few hundred MeV, which was now accessible, was most important.

In the course of such collisions, however, it was also known that new particles called mesons were produced, just as at lower energies light quanta were produced in the collision of electrically charged particles. A close knowledge of the emission of light was, in fact, essential to a clear understanding of the electric forces that govern the motion electrons in atoms, and similarly it was of expected that more information about the properties of mesons would help to elucidate the phenomena that take place when fragments of nuclei collide. Faster particles would also allow us to settle the old problem whether the proton, i.e., the hydrogen nucleus, which was one of the important nuclear constituents, possessed, like the electron, a counterpart of opposite charge. The least energy required to produce such "negative" protons was about 1000 MeV, but in practice rather more would be needed.

All this, however, was only part of the story, because in addition to the questions that could be asked already, new phenomena were bound to be discovered in the field of high energies of which we had yet no indication, and in this possibility lay the most exciting aspect of the new developments for those interested in the fundamental laws of Nature.

Mr. D. W. Fry, of the Atomic Energy Research Establishment, Harwell, dealt with the linear electron accelerator. He said that the need for high energy particles for research in many branches of physics was now well recognised. Since about the time Cockcroft and Walton produced the first artificial disintegration of the lithium nucleus in 1932, many ways had been proposed for accelerating particles. Some of those which had reached advanced stages of development were the resonant transformer, the electrostatic generator, the C.W. and frequency-modulated C.W. cyclotron, the betatron and the synchrotron. Particle linear accelerators were also operated successfully in the 1928–32 period, but their development was not continued at that stage because of the serious technical problems to be solved if 100s or even 10s of MeV energy particles were to be produced.

The development of centimetre techniques and high-pulse powers for radar made the reconsideration of particle linear accelerators again of interest about 1945–46. There were both scientific and economic reasons for this. Two of the main ones were (*a*) to avoid the radiation losses which become large for very high energy electrons travelling round a cyclic accelerator, and (*b*) because linear accelerator costs should be a linear function of energy compared with something proportional to E^2 or even a higher power.

The design of different forms of microwave linear accelerators started in many laboratories. At the A.E.R.E. attention was concentrated upon the travelling wave method, and an instrument was built to accelerate electrons to the comparatively modest energy of 3·5MeV, in order to establish its principles. The results of the joint studies of the members of the staff of the Medical Research Council and the A.E.R.E. are now being embodied in the design of linear accelerators for 4 and 10MeV. The 4MeV instruments, which are to be installed by the Ministry of Health at a number of Regional Centres will have an accelerating tube 1m long mounted across a 12in long gantry in such a way that setting up of the patient is made a simple procedure. The mean beam energy will be $4{\cdot}0 \pm 0{\cdot}5$MeV,

and the X-ray output not less than 200r/min at 1m without filtration.

The 10MeV accelerator is for installation and use at the Medical Research Council's radiotherapeutic unit under the direction of Dr. Constance Wood at the Hammersmith Hospital, and it is now in an advanced stage of assembly at the Metropolitan-Vickers Electrical Co., Ltd. Its construction and operation were shown by means of lantern slides, and it was stated that functional tests would be started very shortly.

In conclusion, Mr. Fry discussed the possible development of linear electron accelerators for energies in the region of 1000MeV, and said he believed that one project for this energy range, and using a metal corrugated guide of the type adopted in the accelerators he had referred to, was being actively worked upon at Stanford University, California. With guides of this type, peak powers in the region of 200MW to 300MW, or even higher, on a wave length of 10cm, were required. To produce this power demanded a large amount of valve research and high-frequency engineering effort. However, theoretical considerations showed that appreciably higher efficiency wave guide systems, demanding less power, should be practical. Promise was held out for a 1000MeV accelerator with a total r.f. power consumption of about 50MW. Some experimental work on dielectric loaded guides was now being done; more remained to be done, but he felt confident that satisfactory solutions could be found for the outstanding technical problems.

Dr. L. U. Hibbard (Physics Department, Birmingham University) gave some details of the Birmingham proton synchrotron, which has been under construction for three years. It is designed to accelerate protons (hydrogen nuclei) to over 1,000,000,000V energy in one second by an applied alternating voltage of only 240V R.M.S. The particles are kept on a fixed circular orbit of 30ft diameter by means of an annular magnet. As the particle energy increases, the magnet field must increase in step in order to keep the orbit fixed. The field rises to 15,000 gauss in one second. The particles are accelerated by receiving impulses twice per revolution, once when entering and once when leaving a long "drift" tube. The impulses are given by the applied alternating voltage, the frequency of which must increase in step with the particle speed. Particles go 7,000,000 times round the orbit and the frequency of the accelerating voltage increases about thirty times during this period. The final frequency is nearly 10,000,000 c/s when the proton speed reaches 91 per cent of the speed of light.

The magnet consists of 2400 vertical C-shaped plates packed together tightly in the form of an annulus. The C-gap in each plate is on the outside and the particles move in the ring space so formed. The plates are flat and $\frac{1}{2}$in thick. They are slightly inclined to each other, and machined wedge plates are inserted in order to fill the gaps between plates at the outside radius and make the structure tight. Wedge-shape gaps are left between plates at smaller radii and are used as air ducts for forced cooling of the windings. This air is supplied by a centrifugal fan in the space at the centre of the annulus. The magnet winding consists of twenty-four turns of heavy stranded conductor wound in the central space of the C and embracing the complete magnet.

The magnet is excited by a pair of d.c. generators connected in parallel. The generators are excited to 1100V and then suddenly switched across the magnet windings. Current builds up from zero to 12,000A in one second, giving a field of 15,000 gauss in the C-gap. Energy is withdrawn from the magnet by reversing the excitations of the generators, making them function as motors driven by the magnet. The generators are coupled directly to a mains-operated a.c. motor, but peak energy requirements are largely supplied and absorbed by a 36-ton flywheel on the same shaft.

The protons travel 120,000 miles round the magnet. In order that they should not drift outside the allocated space, it is necessary to shape the magnetic field to give automatically focusing forces. This is done by tapering the magnet pole faces so that the field falls off slightly with increasing radius. It is also necessary to reduce the number of collisions with gas atoms. This is done by enclosing the particle space in a porcelain vacuum chamber, which is pumped to a pressure of about 10^{-6}mm of mercury.

Finally, it is necessary to relate the frequency of the accelerating alternating voltage very accurately to the magnetic field. The highest accuracy required is when particles are injected, at which instant an error of $\frac{1}{4}$ per cent can be permitted. The required frequency is generated by a beat oscillator with a rotating condenser whose speed is accurately correlated—by means of an elaborate servo system—with the voltage applied to the magnet.

Dr. T. G. Pickvance (Head of Cyclotron Group, A.E.R.E., Harwell), describing experiments with the 110in Harwell cyclotron, said that frequency-modulated cyclotrons, of which the Harwell machine was an example, had been developed during the last few years, principally at Berkeley, in the Radiation Laboratory of the University of California, where Lawrence produced the first cyclotron in 1932. In the following years cyclotrons in many laboratories, including two in this country, contributed to the rapid advance of nuclear research. The limits of applicability of the ordinary cyclotrons were already approached in 1939, when the construction of a very large machine was started in Berkeley. The work was interrupted by the war, and the magnet intended for the large cyclotron was used temporarily for other purposes. After the war, it formed the basis of a cyclotron of a new kind—the frequency-modulated cyclotron or synchrocyclotron, which can accelerate particles to much higher energies than those obtainable in an ordinary cyclotron.

A cyclotron for Harwell was started towards the end of 1946, and was first operated at the beginning of December, 1949. It was designed for the acceleration of protons, the maximum energy being 175MeV with a mean beam current of about 1·5 micro-amperes.

The magnet has straight-sided poles, 110in in diameter and 12in apart. The yoke and poles are built of 670 tons of low-carbon steel in 10-ton plates, and the windings contain 70 tons of copper strip. Power consumption is about 350kW for the normal centre field of 16,500 gauss, and the windings are oil cooled. A stainless steel vacuum chamber is sealed to the sides of the magnet poles. It is evacuated to a pressure of about 10^{-5}mm mercury by three 20in diameter oil diffusion pumps with a speed of 10,000 litres per second. The volume of the vacuum system is about 12,000 litres.

A single copper accelerating electrode, the "dee," is mounted between the magnet poles, with a grounded copper sheath which concentrates the electric field and effectively acts as a second "dee." The "dee" is supported by a system of resonant coaxial transmission lines, one of which is terminated by a motor-driven condenser to provide frequency modulation. The condenser is placed in region of low magnetic field to reduce losses due to eddy currents in the rotating parts. A single triode valve is coupled to the resonant lines so that the whole system operates as a grounded-grid oscillator. All parts of this system, which carry large radio-frequency currents, are water cooled. A d.c. bias voltage is applied to the "dee" and lines, to collect stray electrons which would otherwise oscillate in the radio-frequency electric field and would produce discharges, heavily loading the oscillator. In fact, the machine will not operate without this bias voltage.

The protons are produced in the centre of the machine, between the "dee" and the grounded sheath, by a low-voltage arc discharge in an ion source containing hydrogen. An adjustable probe target may be set at any radius so that the proton beam may be intercepted at any energy from 0 to 175MeV. Apparatus may be inserted on the probe through an air lock, without disturbing the vacuum.

When the cyclotron is operating, large numbers of neutrons are ejected from the target by the proton beam. The neutrons are of high energy and are very penetrating, and protective shielding is provided by the underground installation of the machine. The roof of the underground enclosure is a layer of reinforced concrete 6ft thick, and this has been found to give adequate protection. It is unsafe for anyone to enter the cyclotron enclosure during operation, and the machine is remotely controlled by a system incorporating safety interlocks and protective devices.

A programme of nuclear research was begun immediately after the start-up of the cyclotron and the main programme has consisted of investigation of the interaction between protons and neutrons, although experiments have been performed in other fields. The next experiment in this programme will be to measure the angular distribution of neutrons scattered by protons.

(To be continued)

Road Problems in Nigeria

In 1946, the Government of Nigeria invited the Director of Road Research of the D.S.I.R., United Kingdom, to send a representative to Nigeria to assist the Public Works Department in the development of a materials testing laboratory and to study the methods employed in road construction and maintenance. An officer of the Road Research Laboratory accordingly paid two visits to the Colony, and a report of the first visit was subsequently submitted to the Nigerian Government. The substance of that report, together with information derived from the second visit, has now been published ("Colonial Road Problems: Impressions from Visits to Nigeria," by H. W. W. Pollitt. London: H.M. Stationery Office, price 3s.), in the hope that it will be useful to engineers in the Colonial territories and to others concerned with road construction.

The report is well illustrated and gives a general description of the conditions and practices governing road construction in Nigeria. It then goes on to discuss the particular problems of road construction in that Colony, with special reference to the corrugation and erosion produced in the dry and wet seasons respectively on the local soils and materials. There is then a discussion of the application of modern low-cost methods of construction, employing bituminous material, soil cement or other mechanical stabilisation. There are also chapters on the need for a materials laboratory to supervise and control new works, and the need for research. The report concludes with a general discussion and an appendix describing a similar visit to the Gold Coast.

STEEL ARCH HANGARS AT IDLEWILD AIRPORT, U.S.A.

FIG. 1—COMPLETED UNIT OF THREE HANGARS

FIG. 2—PLACING OF RADIANT HEATING FLOOR PIPES

FIG. 3—ERECTION OF CROSS FRAME BRACING

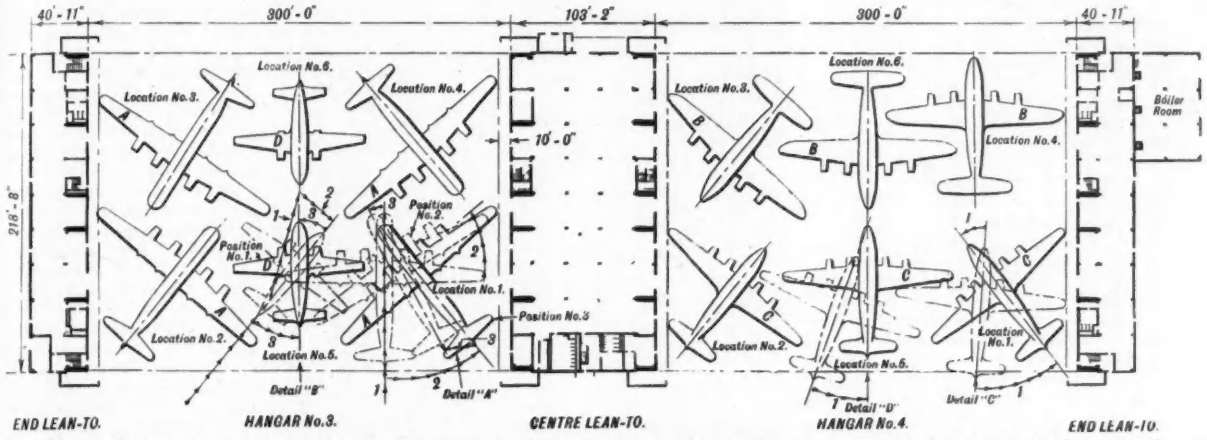
FIG. 4—HANGAR IN COURSE OF ERECTION

Steel Arch Hangars at Idlewild Airport

THE New York International Airport at Idlewild, Queens, covers an area of 4900 acres and is considered to be the largest commercial airport in the world. It was opened in July, 1948, and is intended mainly as a terminal for long-range flights, the older La Guardia Airport being destined to become New York's terminal for short and medium-length flights within a radius of 500 miles of the city. Idlewild Airport has runways now in use ranging from 6000ft to 8200ft in length, with a 9500ft long runway available when needed. All of these runways are 200ft wide. Until recently, only two large hangars, having a combined floor area of 103,000 square feet, were available, but in June, 1950, the construction of a unit of three additional hangars was completed.

Initial discussions and design studies for these new hangars determined that the basic hangar design had to be versatile as it was not possible to specify exactly how the hangars would be utilised or what size or combination of aircraft might eventually be housed. Furthermore, it was decided that such permanently constructed hangars had to be in use long enough at a normal rental to amortise the capital investment of 9,000,000 dollars involved, and, therefore, would have to house readily the largest commercial aircraft under construction, or on the board, at the time of design. Fig. 5 illustrates the manner in which a maximum number of current large aircraft, such as three Constellations and three Douglas DC4s, may be housed within the floor space of 65,300 square feet of each of the new hangars.

Another functional requirement of the hangar design was the necessity for the individual hangar to be a standardised unit which could



NOTE.—Hangar No. 3 movements : Place aircraft in location No. 1. Move aircraft assigned location No. 5 to position No. 1 and hold. Place aircraft in location No. 2, then move aircraft into location No. 5. Movements shown in detail *A* are the same for all Boeing 377 aircraft.

A—Boeing 377. *B*—Constellation 749. *C*—Douglas DC 4. *D*—Consolidated Vultee 240.

FIG. 5—MAXIMUM HANGAR USAGE

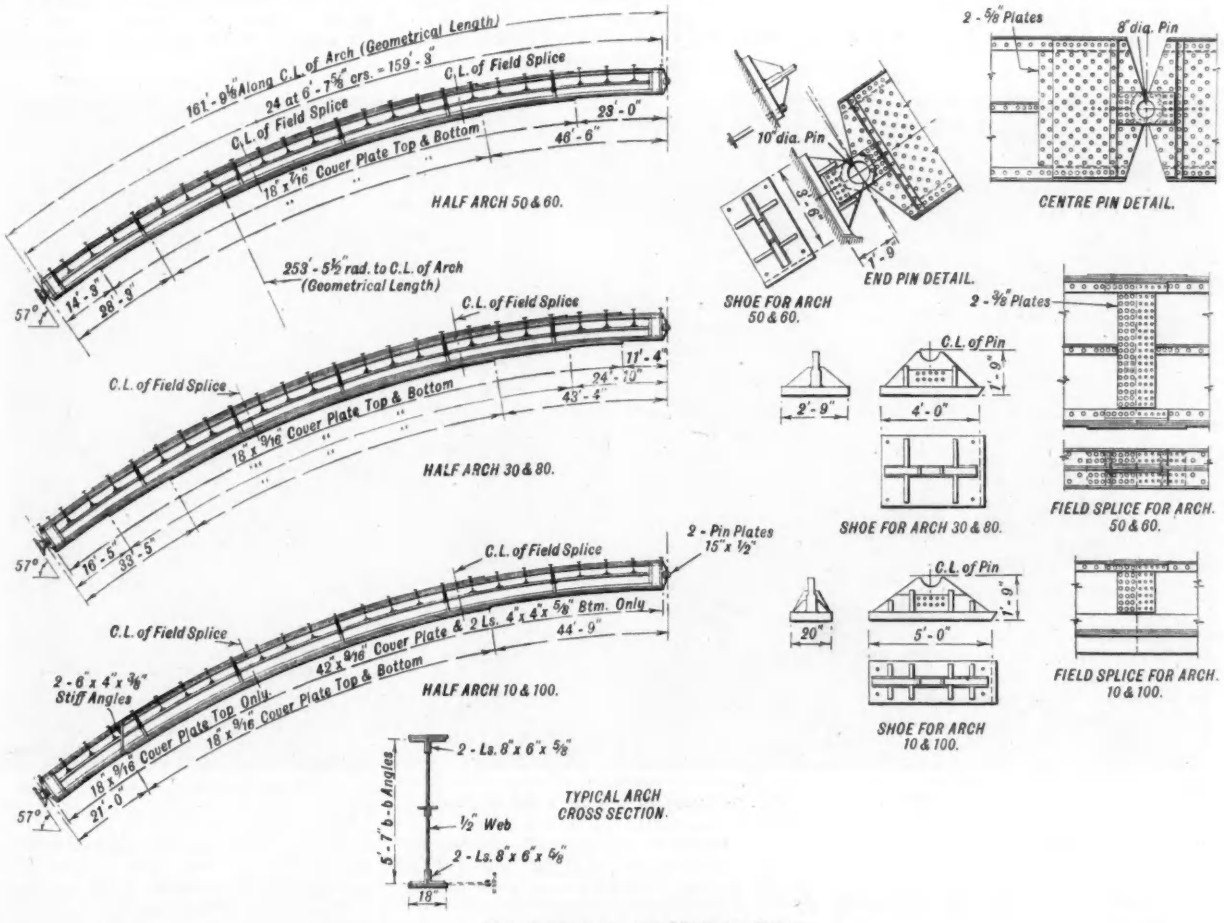

161' - 9⅛" Along C.L. of Arch (Geometrical Length)
24 at 6' - 7⅝" crs. = 159' - 3"
C.L. of Field Splice
18" x 9/16" Cover Plate Top & Bottom
23' - 0"
46' - 6"
HALF ARCH 50 & 60.
253' - 5½" rad. to C.L. of Arch (Geometrical Length)
57°
14' - 3"
28' - 9"
11' - 4"
24' - 0"
43' - 4"
HALF ARCH 30 & 80.
16' - 5"
33' - 5"
2 - Pin Plates 15" x ½"
18" x 9/16" Cover Plate & 2 Ls. 4" x 4" x 5/8" Btm. Only
44' - 9"
2 - 6" x 4" x 3/8" Stiff Angles
18" x 9/16" Cover Plate Top Only
42" x 9/16" Cover Plate Top & Bottom
21' - 0"
HALF ARCH 10 & 100.
2 - Ls. 8" x 6" x 5/8"
½" Web
5' - 7" b. - b. Angles
18"
TYPICAL ARCH CROSS SECTION.
2 - 5/8" Plates
8" dia. Pin
10" dia. Pin
CENTRE PIN DETAIL.
END PIN DETAIL.
SHOE FOR ARCH 50 & 60.
2 - 3/8" Plates
C.L. of Pin
2' - 9"
4' - 0"
SHOE FOR ARCH 30 & 80.
FIELD SPLICE FOR ARCH. 50 & 60.
20"
5' - 0"
SHOE FOR ARCH 10 & 100.
FIELD SPLICE FOR ARCH. 10 & 100.

FIG. 6—DETAILS OF HANGAR ARCH

be repeated and adapted to varying conditions of foundation in case of future expansion. These considerations led to a prototype design consisting of a main arched hangar as a standardised unit with a number of different lean-to buildings attachable at either side to provide approximately 108,000 square feet of office and workshop space needed in conjunction with the maintenance work undertaken in the hangars. Alternative structural steel and reinforced concrete arch hangar designs were prepared and tendered for, and the lowest tender was received for the steel construction, though the lowest tender for reinforced concrete was reasonably close.

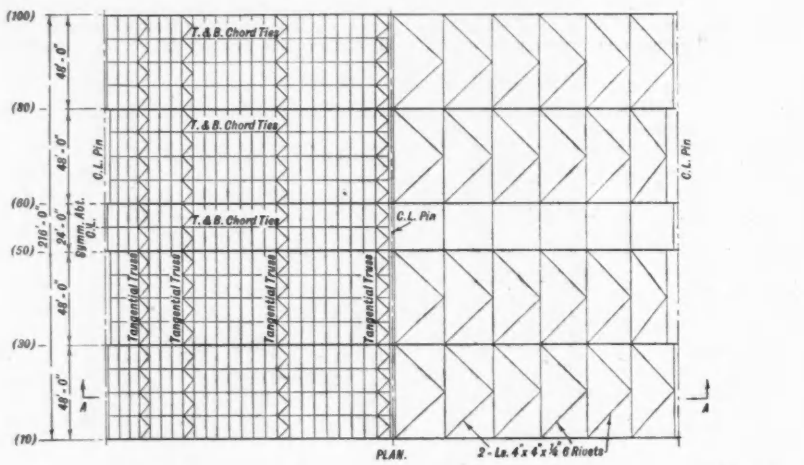


FIG. 7—PLAN AND SECTION OF HANGARS

The structural design of the steel arch hangar is shown on the drawing reproduced in Fig. 7. Each hangar has six three-hinged arches, spaced symmetrically over a depth of 216ft. The arches have a clear span of 300ft and a central rise of 49ft 10 $\frac{11}{16}$in, giving a clear height at the centre line of the hangar of 75ft. The area between the arches is framed with built-up truss purlins and struts at 6ft 7$\frac{5}{8}$in centre spacing, the top chords of which bear on the top of the arch, thus providing a smooth surface for the outside of the hangar roof. The framing is laid out so that the arch is well braced at the top flange and along its centre of gravity by means of K-bracing. The purlins and struts are braced by means of cross frames. Hangers are used to suspend the framing for the hung ceiling, the hangar lighting and the sprinkler system. Metal decking is used for framing between the purlins.

The arch hinges at the springing line are anchored to reinforced concrete columns 25ft high, 15ft wide and 3ft thick, resting on pedestals, which, in turn, carry the load to the footings. Individual spread footings are used for the exterior columns and combined spread footings for the interior columns. No tension ties are used. The footings in the edge lean-to buildings are trapezoidal in plan and vary in depth from 10ft to 3ft. The footings in the centre lean-to buildings are rectangular in plan and have a constant depth. Most of the lean-to columns are supported by the arch footings. The hangar floor slab, which rests on compacted limestone, has been designed for aircraft weighing 135 tons, and varies in thickness from 11in to 14in at the expansion joints. There is one longitudinal and one transverse expansion joint in each hangar, and dummy joints further sub-divide these areas into 24ft squares. The six service pits in each hangar floor have compressed air, electrical outlets and drains. There is a set of doors, having twelve leaves, at each end of the hangars with a clear opening 40ft high by 285ft. Also at each end of the hangar there is a tailgate door, 22ft high and 33ft 7in wide to provide clearance for planes with large tail sections. These tailgates are of the turnover canopy type. To prevent frequent opening of the large hangar doors, there are two vertical lift doors, 8ft by 8ft, and one pilot door built within the main doors. The upper portion of the hangar doors is glazed to produce even distribution of daylight over a large interior floor space. Hangar doors roll on tracks embedded in the concrete foundation. The wind loads on the doors and front closure walls are transmitted by steel trussed frames to the first two arches. All the doors are motor operated and electrically interconnected. Provisions are made for emergency hand operation.

Structural details of the built-up hangar arch are reproduced in Fig. 6. It comprises a $\frac{1}{4}$in web stiffened at mid-depth by two 4in by 4in by $\frac{1}{2}$in angles. The depth back to back of the 8in by 6in by $\frac{5}{8}$in flange angles is constant at 5ft 7in. The flange plates are 18in wide and vary in thickness from $\frac{7}{16}$in to $\frac{1}{16}$in. The end pins are of 10in diameter, while the pin at the crown has a diameter of 8in. The original design allowed for two field splices on each half arch, but the fabricator of the steelwork,

FIG. 8—HANGARS UNDER CONSTRUCTION

the American Bridge Company, was able to erect the structure with only one splice provided for. The entire steelwork is of riveted construction. The structure was designed to withstand a 100 m.p.h. wind load on all outside surfaces and a 40 lb per square foot live load was allowed for. The wind was assumed to exert an inward pressure of 20 lb per square foot against the exterior of one vertical side of a hangar and to exert outward pressures ranging from 13 lb to 23 lb per square foot against the other side and the roof. A temperature differential of 40 deg. Fah. was used in the design of the arch, and a ½in translation of each springing was assumed.

To obtain optimum floor level temperatures, it was decided to use a radiant heating system, circulating water at approximately 140 deg. Fah. and heating the working zone in the hangar floor areas to 65 deg. Fah. Each hangar contains about 10 miles of 1¼in piping, spaced at 18in centres and buried 6½in below the floor. Fig. 2 shows the placing of a bank of piping prior to the pouring of the concrete floor. A special supporting rig is being used. Compressed air lines and electrical conduit were also installed before concreting. The heater panels are of the grid type in which the water is circulated from a supply header to a return header and not through a continuous coil. This eliminates long, continuous runs of pipe which would require high pumping heads and possibly cause circulating difficulties. Pipe coils at 10½in centres are provided in the door pockets and directly beneath each door track rail. Plans provide for the future installation of four unit heaters per hangar, one at each corner to take care of the additional load when the doors are open during cold weather, if operational experience indicates that this arrangement is necessary.

A complete local fire alarm and sprinkler system is provided for the entire unit as its location is isolated in relation to other parts of the airport. The sprinkler system for the hangar is of the deluge type divided into six separate zones. The automatic control valves provided for these six systems are installed in the edge lean-to buildings. The systems are automatically operated from heat-sensitive devices installed in the ceiling.

The hangars have high-bay lighting fixtures, which project the light down to the floor surface (the working level) with maximum effect considering the high mounting which must be utilised. The fixtures are provided with two types of lamps—a standard incandescent lamp and a mercury vapour lamp, to produce an average uniform intensity of 38 foot-candles. The mercury vapour lamps, in combination with the incandescent ones, will produce a bluish-white light of good colour and quality. Floodlights are provided over each hangar door to illuminate the apron area in front of the doors. Obstruction lights are provided on top of the roof of each hangar building and on the outside parapet wall of each edge building. The control of these obstruction lights is designed to be automatic through photo-electric control units. They switch on when daylight drops to 35 foot-candles and off when it rises to 55 foot-candles.

Progressive stages in the erection, with the aid of crawler cranes and four-post timber props, of the three arch hangars, which are claimed to be the world's largest, are illustrated in Figs. 3, 4, 8 and 9. Altogether, the erection of the complete unit took only thirteen months. The structural design was executed by Roberts and Schaefer Company, Chicago, for the Port of New York Authority, which operates the Idlewild Airport.

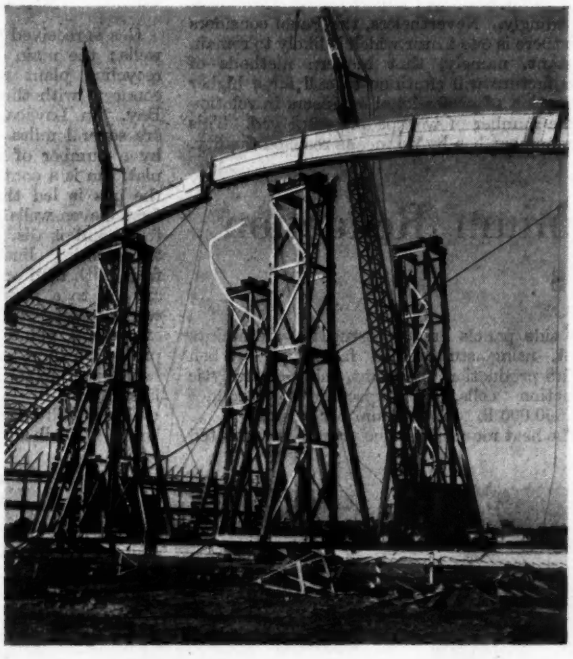


FIG. 9—ERECTION OF PLATE GIRDER ARCH

Demand for Mechanical Engineers*

THERE are two principal training grounds for qualified professional engineers, viz., the universities and the technical colleges; and, in addition, there are the training schools run by large firms. The firms' schools are usually closely associated with and greatly assisted by the local technical colleges. The graduates come mainly from the universities, although the technical colleges provide some internal and external graduates. The firms' schools sometimes encourage their most promising students to go on for degrees. The technical colleges produce all the engineers who qualify by obtaining the Higher National Certificate.

GRADUATES

It is estimated that before the war the universities produced on an average about 150 mechanical engineers a year between 1926 and 1939. From figures supplied by the University Grants Committee it is calculated that during the post-war years the following numbers have been or will be graduating in mechanical engineering:—1947, 416; 1948, 430; 1949, 520; 1950, 528. These figures show that the present output from the universities is more than three times the pre-war output.

HIGHER NATIONAL CERTIFICATES

The number of Higher National Certificates in mechanical engineering and production engineering awarded in the United Kingdom shows an even greater increase. The 1938 figure was 561 and the numbers for the post-war years, which include Higher National Certificates awarded after the special intensive courses as well as the ordinary courses, are as follows:—1945, 1977; 1946, 2052; 1947, 1944; 1948, 2551. These indicate that there are four and a half times as many as before the war obtaining this qualification. It will be seen that the ratio between university degrees and Higher National Certificates of approximately 1 : 4 is about the same before and after the war. The National Certificate system and part-time education supply not only a considerable proportion of the requirements of professional engineers, but also a very large proportion of the technicians employed in industry. At least a half of those who obtain Higher National Certificates will be required for employment as technicians.

It is difficult to give any reliable estimate of what numbers of persons will qualify as professional engineers in the next five to ten years. As the figures already quoted show, there has been a continuous increase in the past few years and so far as the universities are concerned the increase will continue at least until 1950. Some of the increase is, of course, due to men whose careers and education were interrupted by the war resuming their studies on discharge from the Forces, many of whom were assisted by grants under the Further Education and Training Scheme. Few men will be able to qualify under this scheme after 1949. The general improvement in ordinary education has also probably influenced some others to qualify for professional posts. The great need of industry for more staff of this kind has led more firms to initiate student apprenticeship schemes and to encourage suitable young men to study for the Higher National Certificate and sometimes to graduate. All these factors have affected the supply position.

Although a number of graduates are required on the manufacturing side and for maintenance, the greatest need for such activities is for the type of man who has had sound practical training preferably as an apprentice before he goes to the technical college or university and, in addition, a good theoretical training at a technical college or university. A much greater proportion of university men (with or without previous practical experience) is needed in research, design, development and commercial work. The supply of such men seems to be assured at any rate in the near future and the Panel has no reason to think that there will be a reduction in the flow so long as the demand continues.

CONCLUSIONS AND RECOMMENDATIONS

Modern methods have stimulated a demand for many more professionally qualified engineers than it was customary to employ before the war. This is specially so in industries, outside the engineering industry, where machinery is used in production. Subject to the reservations stated in the final paragraph below, there is no reason to suppose that the present tendency to increase the professional staffs will be halted during the next ten years.

Although the anticipated demands are substantial, the Panel considers that they will be adequately met over the course of a few years if the present rate of training qualified engineers continues. There is no evidence to suggest that the flow will diminish so long as the demand remains.

The additional demands are not entirely for extra workers in the industry, but are often no more than a need for a higher proportion of qualified engineers on the staff. A substantial proportion of the demand can be met by encouraging the best craft apprentices to seek and train for professional qualifications.

There is a good deal of evidence to show that the requirement for professional mechanical engineers employed at the present time is twice the pre-war demand, but that, by the end of the next ten years, it should be about two and a half times the pre-war figure. In addition to this requirement, an increasing number of engineers is needed for employment as technicians, the main supply of whom will come from the National Certificate scheme. The total requirement of persons obtaining Higher National

* Abstract from a Report to the Minister of Labour and National Service by the Mechanical Engineers' Panel of the Engineering Sub-Committee appointed by the Technical Personnel Committee. The Report is entitled "Present and Future Supply and Demand for Persons with Professional Qualifications in Mechanical Engineering." It is one of a series of similar reports, issued by H.M. Stationery Office, prepared at the request of the Minister "to throw light on the future demand for professional personnel in the various branches of science, engineering, surveying and architecture, and also on the relationship of demand to future supply."

Certificates may be three and a half to four times the pre-war figure. It is therefore necessary to provide facilities to meet this increase. This provision is necessary apart from the facilities that will be needed to provide for compulsory day-time releases when the appropriate section of the Education Act, 1944, comes into operation.

Finally, the Panel wishes to draw attention to the fact that employers and others who have given estimates of their requirements for professional engineers have had to make certain basic assumptions in order to make an assessment. It seems probable that most of them have assumed that the present trading position, both in the home and overseas markets, will continue into the near future. Events may, of course, falsify this assumption. Those who read this report and think the position in the next five to ten years will be substantially different from the present will have to make allowances accordingly. Nevertheless, the Panel considers that there is one factor which is likely to remain constant, namely, that modern methods of manufacture will continue to call for a higher proportion of professional engineers in relation to the number of workpeople employed. This development has by no means reached finality.

Point Comfort Aluminium Reduction Works

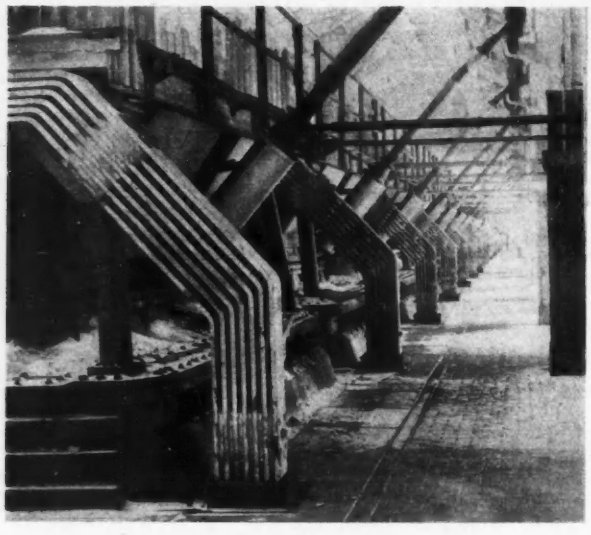
THE Aluminum Company of America has recently opened its new Point Comfort Aluminium Reduction Works; excavation work began in 1948 and the first aluminium was poured in February of this year. The site selected was on Matagorda Bay, near Port Lavaca, Texas, and a short branch railroad connects the works with the Missouri-Pacific Line, while a canal links the works' dock with the Pass Cavallo-Port Lavaca channel. As completed, the works consist of twenty-five buildings, having a floor area of 18½ acres, and it is interesting to note that the roofing and side panels are of corrugated aluminium sheet, using stud-welded fastenings. When in full production the plant, using electrolytic reduction cells, is expected to produce 114,000,000 lb of aluminium per annum.

The heat required for the process is generated by electric current, and as it takes about 10kWh to produce one pound of metal, cheap electrical power has been an economic necessity. For this reason hydro-electric power is usually used, but in this instance the power required is generated by batteries of Nordberg two-cycle radial diesel engines, driving the generators and using gas piped from the neighbouring natural gas fields, the existence of which was the principal reason for choosing the Point Comfort area as the site for the new works.

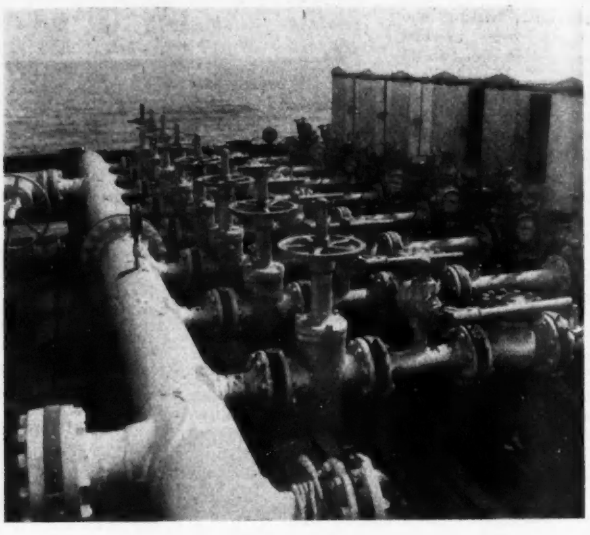
Natural Gas Supply

Gas is received from both land and off-shore wells; the main land line links up with a recycling plant at Francitas, while another connects with the off-shore line in Matagorda Bay. In Lavaca and Matagorda Bays there are several miles of main underwater line fed by a number of gathering lines. On a piled platform is a control and metering station and the gas is led through the gathering system from eleven wells to a 12in header on the platform and is discharged into an 8in diameter transmission line. The transmission lines from both land and off-shore gas supply points are led to a pressure reducing station at the works. Magnesium anodes have been installed at several points in order to give cathodic protection and aluminium alloy piping has been used experimentally for one gathering line.

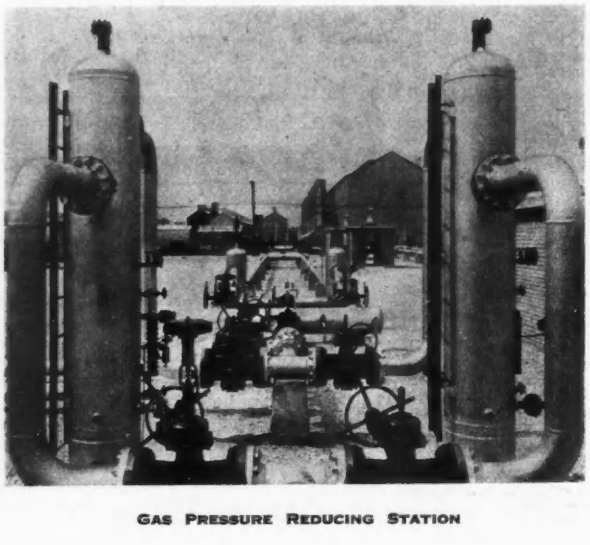
Gas is delivered to the works at a pressure between 400 lb and 500 lb per square inch and is subsequently reduced to 60 lb per square inch in two stages. Two 8in diameter pipe-lines connect the pressure-reducing station with the three power-houses and a regulator at each engine intake reduces the pressure to 6 lb per square inch. There are a total of 120 engine-generator units, forty in each power-



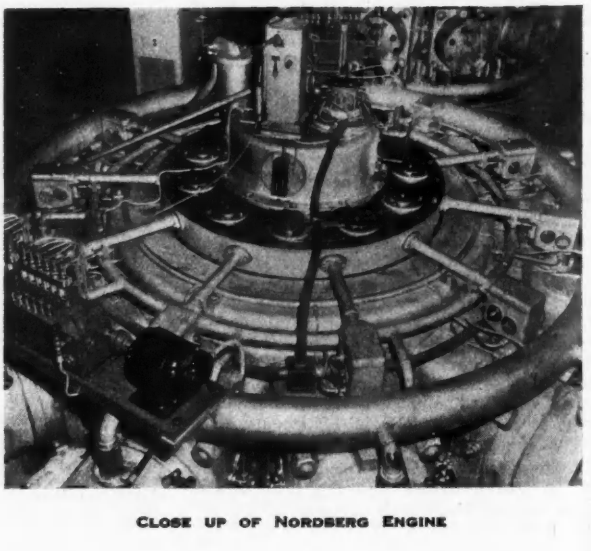
ELECTROLYTIC CELLS



CONTROL STATION, MATAGORDA BAY



GAS PRESSURE REDUCING STATION



CLOSE UP OF NORDBERG ENGINE

house and each engine consumes 13,000 cubic feet of gas per hour under load, so that the daily consumption of the plant will exceed 30,000,000 cubic feet.

Power Plant

The 120 engine-generator units converting gas into electrical energy have a nominal generating capacity of 120,000kW and a total output of 2,750,000kWh per day. Produced by the Nordberg Manufacturing Company, Milwaukee, Wisconsin, United States, the spark-fired radial engine has eleven cylinders of 14in diameter by 16in stroke, and it is arranged to burn gas, a special head being fitted to give approximately one-half of the compression used when burning diesel fuel. The engine, which requires about 18ft headroom and a little more than 12ft by 12ft of floor space, develops 1600 h.p. at 360 r.p.m., the thermal efficiency being approximately 30 per cent and the unit weight per horsepower, 39 lb.

The natural gas fuel is admitted to each cylinder through a cage-mounted valve, which is operated by a rocker arm and push-rod actuated by a cam on the crankshaft. No valves are required, the intake of air and discharge of exhaust being timed by the uncovering of ports by the piston. The gas is admitted into the path of the incoming scavenging air to ensure complete mixing and the amount of gas is varied according to the engine load by means of a valve controlled by a hydraulic governor.

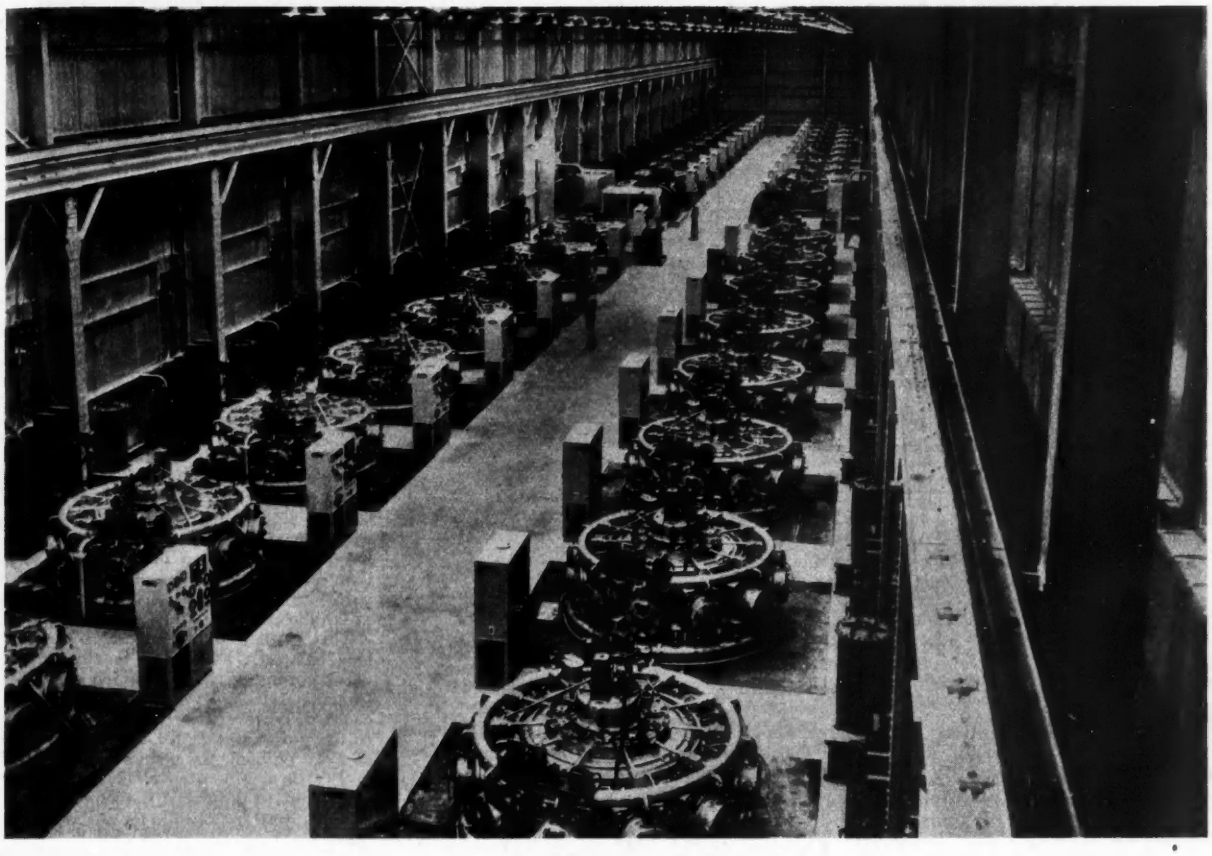
The water-jacketed cylinders of close-grain cast iron are bolted to the one-piece cast iron main frame, which has reinforcing ribs and a central hub containing the lower crankshaft bearing bushing and the thrust bearing supporting the weight of the vertical crankshaft and the generator rotor. Of high tensile alloy cast iron, the two-piece crankshaft has an integral thrust collar. The upper crankshaft main bearing bushing is contained in the engine cover, upon which are mounted the governor, fuel pumps and gas-control mechanism. Circular manifolds for scavenging and exhaust are located below floor level. For gas fuel aluminium alloy cylinder heads are fitted and the aluminium alloy pistons are in two parts, consisting of piston and cooling ring, which has internal oil grooves and which, after machining, is shrunk on to the piston and welded in place. This construction provides annular passages for the flow of cooling oil between the ring and the piston proper.

The engine breaks away from the established practice of transferring power from the connecting-rods to the crankshaft in that there is no master connecting-rod, but each rod is attached to a master gear at regularly spaced intervals by knuckle pins in bronze bushes. Fitted with a bronze Babbitt-lined bushing to form the crankpin bearing, the master gear is prevented from rotating by pinion gears, meshing with the master gear and with a stationary gear bolted to the top cover. The gear has a gyratory movement equal to the stroke of the piston. The gearing maintains the various parts in a definite relationship and the master gear and counterweights in an optimum position for the absorption of piston thrust, thus promoting balanced operation and freedom from vibration.

There is a separate control panel for each engine and a master control room in each power-house. Each panel incorporates a number of safety devices, which automatically shuts off the engine should the oil pressure fall, the water, exhaust or generator temperature rise or the auxiliary power fail.

Lubrication is effected by two systems, namely, mechanical force feed and circulating pressure. Motor-driven multi-feed lubricators supply oil to two points at the upper end of the cylinders for piston lubrication. The closed pressure system circulates oil to bearings and other parts of the engine and for piston cooling. The system consists of a motor-driven rotary pump, which draws oil from the sump and discharges through a cooler to the main bearing, from where it rises through the hollow shaft and is distributed to the crankpin bearing, the knuckle pins, pinion bearings and the upper crankshaft bearing through passages in the webs of the crankshaft. Drillings in the knuckle pin connect with drillings in the connecting-rods to provide oil to lubricate the gudgeon pins and to cool the pistons.

The combined oil and water cooler includes a heat exchanger consisting of aluminium tubes and fins, and cast iron headers, the tubes being arranged in banks of three. Each exchanger is in four independent sections connected by a common manifold and so arranged that individual tubes can be cut out without affecting the working of the exchanger.



Engine Room

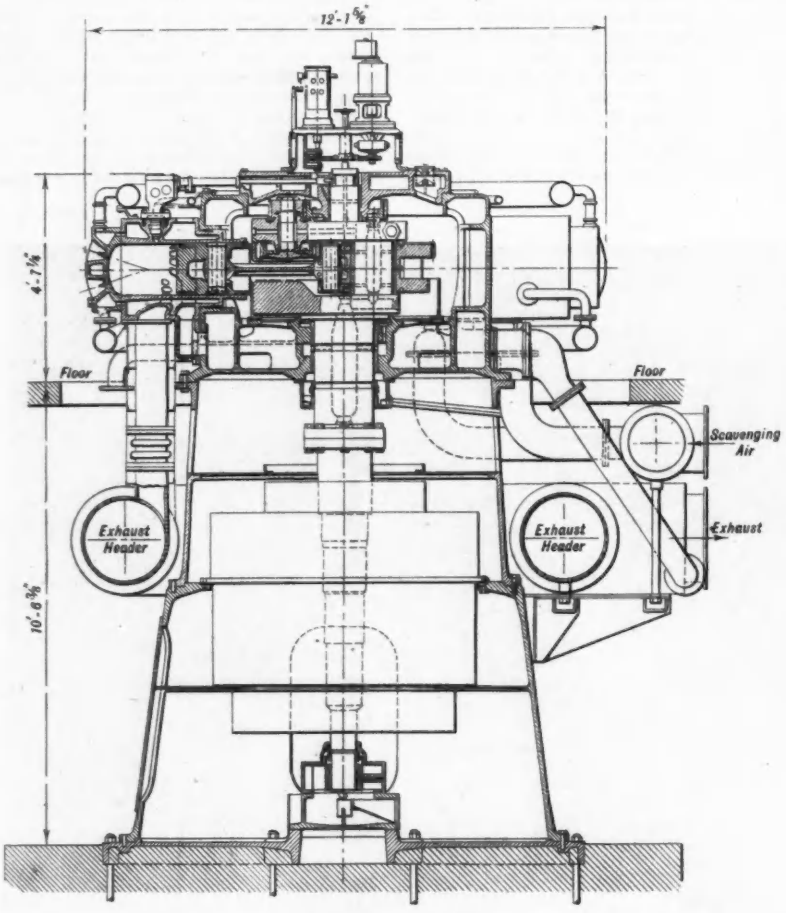
Having six adjustable blades, the 84in diameter heat exchanger fan is powered by a two-speed 25 h.p. motor, while the oil and water circulating pumps are driven by a common 15 h.p. motor.

Scavenger air blowers of centrifugal design, driven by a 100 h.p. motor, supply air under pressure at a maximum of 7000 cubic feet per minute, the quantity varying directly with the engine speed. Each engine-room has forty all-aluminium air-washing units, each containing thirty washer cells and dealing with 35,000 cubic feet of air per minute. A 7½ft diameter exhaust, 50ft high, built of ⅛in thick aluminium alloy plate, is installed at every engine-generator unit to exhaust generator cooling air and air from the heat exchanger.

Electrical Generators

The engine is directly coupled to the electrical generator, which is mounted immediately under it within the sub-base and each unit, together with its auxiliaries, operates independently. Each generator is rated to produce 1000kW d.c. at 667V and 125kVA a.c. at 425V and 24 c/s. By using the a.c. power developed for driving the auxiliaries, the need for an overall auxiliary power system is eliminated together with the possibility of the whole station having to shut down. For starting the unit, power is supplied to the main generator to motor the engine. Cooling air for

the generator is supplied by an axial flow fan driven by a 7½ h.p. motor and delivering 12,000 cubic feet of air per minute.



NORDBERG ENGINE

Four 667V d.c. motor-driven generator sets provide the 60 c/s, 4000V a.c. power for works use and a 250kW, 250V generator on each set supplies power for the cranes. Extensive use of aluminium alloy has been made throughout for busbars, cables, wire and conduit; the towers and substations for the 4000V auxiliary power distribution system are also of aluminium alloy.

Completion of Fannich Tunnel

IN a Journal note in our last week's issue, reference was made to the removal of the final plug of rock between the Fannich tunnel and the bottom of Loch Fannich. This somewhat delicate task, which was known on the site as "Operation Bathplug," completed the construction of the tunnel, which has been in progress for about three and a half years. The tunnel is nearly 4 miles long and is of horseshoe section with an equivalent diameter of 11ft. It is expected that the Grudie Bridge power station, which together with the Fannich tunnel forms the North of Scotland Hydro-Electric Board's Constructional Scheme No. 3, will now be in operation in about a month's time, with an annual output of about 80 million units.

Reference to the attached diagram shows that the tunnel, some 104ft below loch level, was gradually driven towards and underneath the loch from the two shafts forming the screen house and gate house respectively, until it reached a position as close to the bed of the loch as safety requirements would allow. After the tunnel reached this terminal point it was deepened so as to form a large sump to contain the debris from the rock plug still remaining between the loch and the tunnel. The size of the tunnel at this sump was 45ft deep and 17ft wide and was arranged to hold at least twice the estimated amount of rock which would fall into the sump as the result of the explosion, thus ensuring that there was no risk of the tunnel entrance being blocked with debris. Prior to this excavation an extensive programme of scraping loose materials from the bed of the loch was carried out over the area affected, so as to expose the rock. The levels of the rock were carefully surveyed. Pilot holes were drilled forward as the work progressed to confirm the accurate survey which had been made of the loch bed at this point. It was decided to leave a thickness of 15ft of rock as a minimum and this plug had over 100 holes drilled into it, each terminating about 2ft from the surface of the loch bed. These holes were loaded with a total of ¾-ton of explosive. The amount of rock blown by the explosion amounted to about 400 tons.

In order to minimise the effect of the explosion on the tunnel structure itself and to avoid a dangerous inrush of water from the loch, the tunnel from the gateshaft towards the loch was filled with water, as may be seen from the diagram, to a level some 12ft below the level of the loch. This negative head encouraged the shattered debris to fall back into the sump.

It was estimated that the force generated by the explosion would be of the order of 120 tons per square foot. The diagram shows the three protective bulkheads, which shut off the tunnel from the loch and resisted the force of the explosion. No. 1, nearest the loch, consisted of a concrete plug 13ft thick and containing 85 tons of concrete. A second concrete bulkhead, 6½ft thick and containing 40 tons of concrete, was provided 36ft from the main bulkhead. If, for any reason, the instantaneous explosive shock pressure of nearly 10,000 tons on the face of No. 1 bulkhead had caused it to fracture, then No. 2 bulkhead would have come into play. In addition to these two concrete bulkheads, a third and final emergency bulkhead was provided, consisting of a gate of steel joists placed at the bottom of the screen shaft.

After the explosion the two gates in the gatehouse were lowered to the bottom of the shaft, to cut off Loch Fannich from the tunnel. Following this, the demolition of the temporary bulkheads will be put in hand and the tunnel then made ready for supplying water in a few weeks' time from the loch to the power station at Grudie Bridge.

This method of connecting a tunnel to a loch has been little used in this country or abroad owing to the risks which are entailed in tunnelling close to the bed of a loch. In this country, however, the tunnel supplying water to the power station for the aluminium works at Fort William was connected to Loch Treig in 1930 in a somewhat similar manner. It is of interest to note that the same firm of contractors were responsible for the work at Loch Treig.

The consulting engineers for the Fannich project are Sir Alexander Gibb and Partners, and the contractors for the work described in this note were Balfour Beatty and Co., Ltd. Imperial Chemical Industries, Ltd., provided explosives and were consultants for the explosion itself, and Glenfield and Kennedy, Ltd., supplied the hydraulic gates and equipment.

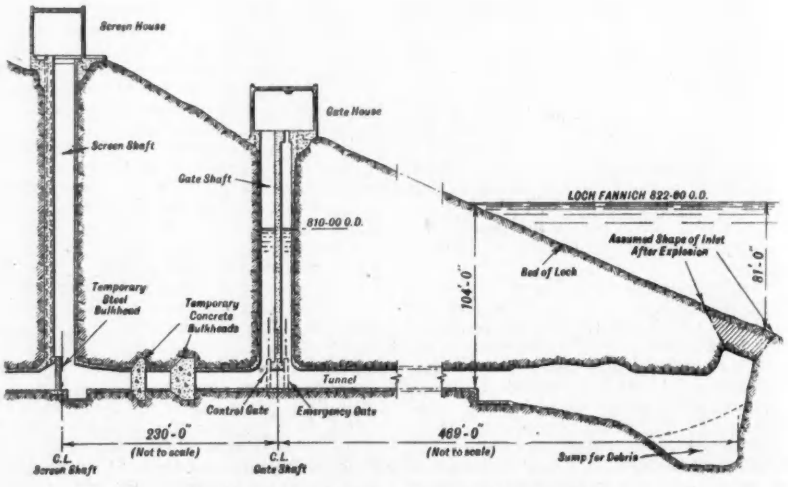
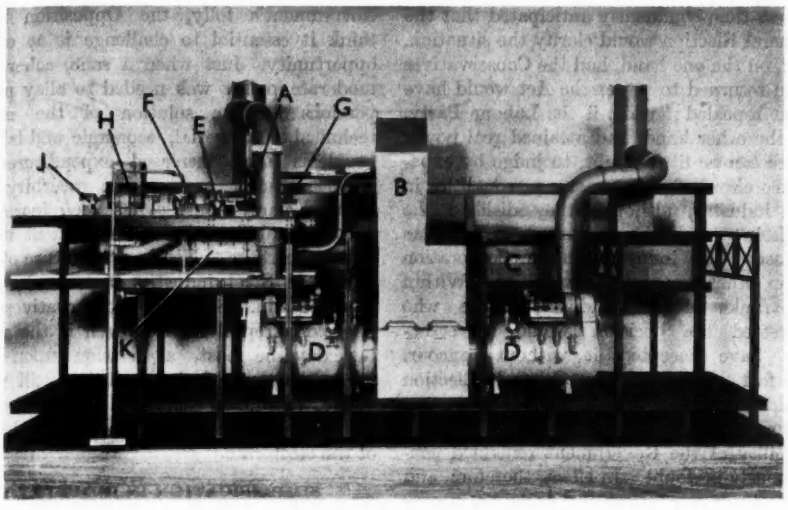


DIAGRAM OF FANNICH TUNNEL EXCAVATION

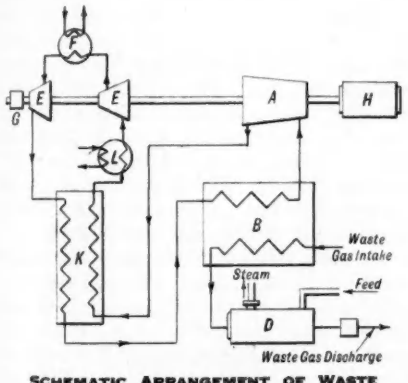
Gas Turbine for a Waste Heat Recovery Installation

WE have received particulars of one of the interesting models shown in the gas section of the exhibition, "Energy in the Service of Man," which was recently organised in connection with the annual meeting of the British Association in Birmingham. This section of the exhibition was prepared by the Gas Council, in co-operation with the West Midlands Gas Board. The model, which is illustrated above, shows the arrangement of a pioneer plant, incorporating a new system of waste heat recovery, developed by Spencer Bonecourt, Ltd., and ordered by the West Midlands Gas Board for installation at a gas works in its area in the near future. The unit has been designed to work in conjunction with an installation of Glover West continuous vertical retorts and is intended to increase still further the overall efficiency of the carbonising process.



MODEL OF WASTE HEAT RECOVERY UNIT

Hitherto, waste heat recovery by means of power and/or process steam production has been effected by the use of appropriate boiler plant. But in view of the comparatively small-size electric generating plant of the average gasworks, the overall efficiency of conversion of heat to power has been relatively low. This new system is designed to take advantage of the improvements offered by the gas turbine on the basis of electricity yield per unit of heat input on relatively small-scale plants.



SCHEMATIC ARRANGEMENT OF WASTE HEAT RECOVERY

Referring to the illustration reproduced on this page, the gas turbine *A* obtains its motive heat from an airheater *B* built in a chamber leading from the waste gas collecting flue *C*; this represents the first stage of heat recovery—in this particular instance reducing the waste gases from 800 deg. Cent. to 475 deg. Cent. The gas leaving the air heater passes through an orthodox waste heat boiler plant *D* to generate steam at 120 lb pressure superheated 55 deg. Cent. for process purposes —chiefly for steaming the coke in the vertical retorts. The air heater for the turbine circuit therefore functions at the high temperature end of the waste gas flow circuit and so, with a relatively high coefficient of heat transfer, it is of moderate dimensions. This main air heater comprises a bank of tubes fabricated from Firth Brown F.C.B. alloy, followed in the lower temperature zone by mild steel tubing: the motive air passes through the tubes with the waste gas on the outside; appropriate cleaning facilities are provided to keep this external surface free from deposits.

The gas turbine unit, with its heat transfer apparatus, is being built by John Brown and Co., Ltd., Clydebank, and will operate on the firms' closed-cycle system. Apart from the advantage of the turbine operating on perfectly clean air, the closed cycle offers advantages in control and (being a pressurised system) makes it possible to cut down the size of pipework used for hot air, &c., this arrangement being of some importance when a plant is located in a retort house and close to the point of availability of heat. The compressor *E*, which is driven directly by the turbine combines centrifugal and axial stages. To obtain optimum compressor efficiency an inter-cooler *F* is arranged between the centrifugal and the axial series of stages, together with a pre-cooler on the air intake to the compressor.

For starting purposes a small steam turbine *G* is mounted on the main shaft. The alternator *H* is driven through single reduction gearing and has a capacity of 700kW, generating at 400V, 60 c/s, and the exciter *J* is coupled to the alternator shaft.

Firth Brown alloys are used for the high temperature end of the turbine and for the turbine rotor shaft. The operating air temperature (i.e., leaving the preheater) is 600 deg. Cent. and is well within the thermal limits of present-day metallurgical practice as applied to gas turbine developments.

The regenerator *K*, which is situated immediately below the turbine, comprises bundles of $\frac{1}{16}$in inside dia. steel tubes in a casing, the circuits being in counter flow, i.e., the turbine exhaust running in one direction to the pre-cooler *L* and the compressed air *en route* to the main air preheater in the other.

The boiler plant follows orthodox Spencer-Bonecourt practice and a complete dampering system will enable either boiler to handle the full quantity of waste gas at maximum temperature for steam generation only should the turbine plant be shut down. The main contractors for the West Midlands Gas Board for this work is Wests Gas Improvements, Ltd., of Manchester.

PERA Road Vehicle and Accessory Manufacturers' Advisory Panel

THE first meeting of the Road Vehicle and Accessory Manufacturers' Advisory Panel was held at the Melton Mowbray headquarters of the Production Engineering Research Association of Great Britain on Wednesday, September 6th. The panel discussed many long-standing problems confronting firms in the search for higher output and lower costs and recommended that the association should undertake research into those problems.

It decided that PERA could render the motor industry valuable assistance by carrying out research into many subjects, and in the course of the meeting the panel strongly urged that PERA should become a clearing house for the free exchange of information on production between manufacturers. Dr. Galloway, the chairman of the panel and the director of research of PERA, agreed that the association should take steps towards this end and recognised the great importance of this aspect of its work.

The panel referred to the need for authoritative information on industrial surface treatments, finishing materials and processes. It considered that industry was also in need of authentic test data on the behaviour of industrial adhesives under varying climatic conditions. In connection with metal forming, the panel asked the association to investigate the thread-rolling characteristics of various materials, and it was also suggested that PERA should assist in establishing sound techniques for impact extrusion of both non-ferrous and ferrous metals. The desirability of establishing formability indices was discussed and proposals put forward that a precise meaning should be given to such terms as soft, quarter-hard, half-hard, &c., as applied to sheet and strip materials.

During a consideration of machining problems, it was repeatedly stressed that an overall reduction in tooling costs was one of the automobile industry's fundamental requirements and specific examples were cited where assistance could probably achieve the desired reduction in costs.

In connection with reamers, members of the panel proposed that the association should carry out a full-scale investigation into the design and utilisation of these tools, which were of such importance to the small-batch producer of components.

It was also considered that substantial economies could be achieved in the dressing of grinding wheels if sufficient information was available on the alternatives to diamond dressing. Among other machining problems raised were the selection and application of cutting fluids in multi-tapping operations; the design and use of core drills; the performance of small drills; economy in the use of carbide tools; grinding-wheel selection, and the importance of establishing machinability indices.

The recommendations of the panel are to be placed before the Association's Technical Policy Committee.

THE ALUMINIUM DEVELOPMENT ASSOCIATION.—The Association has recently issued a directory of members, which includes a brief statement of its constitution and objects, together with the activities and products of the member firms. The aims of the Association, its activities and an outline of its organisation are given in some detail in another new publication.

THE ENGINEER

SEPTEMBER 22, 1950

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NOTICE TO READERS

All letters intended for insertion in THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.

For Subscription Rates, see page 2 of Advertisements.

STEEL IN THE MELTING POT

THE announcement by Mr. Strauss, in the House of Commons last Thursday, that a Chairman and Deputy Chairman, three full-time and two part-time members of the Iron and Steel Corporation, would be appointed on October 2nd, and that vesting day for the nationalisation of the iron and steel industry under the Iron and Steel Act would be as soon after January 1st as practicable, astonished everyone. For it was generally expected in present circumstances that it would seem as reasonable to the Socialist Party as to other parties that the coming into force of the Act should be postponed.

Just a little less than a year ago controversy between the Houses of Lords and Commons about the provisions of what was then the Iron and Steel Bill was stilled by the very sensible decision of the Government to accept an amendment proposed originally by the Lords which had the effect of postponing the coming into force of the measure. Vesting day was fixed at the earliest at January 1, 1951, and the setting up of the Corporation at October 1, 1950. That compromise was accepted by the Government, although the Bill could still have been forced through against the will of the Lords, for the very good reason that the measure could not have been satisfactorily made effective before the General Election due in 1950. For until the country had unequivocally decided which of the political parties was to gain power it was clear that no one of consequence in the industry was likely to prove willing to serve on a corporation which might be dissolved, having effected nothing, within a few months. Furthermore, it must have been recognised that it would be irresponsible to attempt to begin the vesting of the industry in the State when before that vesting could become effective the Act itself might be swept away. It was then confidently anticipated that the General Election would clarify the situation. For, on the one hand, had the Conservatives been returned to power the Act would have been repealed; while if the Labour Party, on the other hand, had attained real power there can be little doubt, to judge by experience elsewhere, that many personalities in the industry, although they disliked the decision, would have desired to continue to serve the industry on the Corporation or in other responsible capacities. Within all ranks of the industry those who regretted the decision would nevertheless have accepted it without rancour. In fact, however, the General Election decided nothing. For the Labour Party was returned with so slight a majority that the stability of the Government remained continuously in doubt. In effect, therefore, and since there was never any certainty that a General Election could be long postponed, the conditions that ruled last Thursday, when Mr. Strauss announced the Government's decision, were closely similar to the conditions that caused the Government to act very differently and to accept postponement last November. At that time last year Mr. Strauss himself recognised, in relation to the appointment of members to the Corporation, that "men who may well be best suited for this responsible task might understandably be reluctant to commit themselves to accepting such a position." After the General Election that situation persisted. As Sir Ellis Hunter has revealed, in a statement issued last week by the British Iron and Steel Federation, that Federation informed the Minister "that it could not see its way to accede to his request to suggest the names of individuals who might serve on the Corporation . . ." The difficulty that the Government has faced in present circumstances in setting up the Corporation is, indeed, revealed by its composition. For, however estimable its personnel may be upon other grounds, it cannot be claimed that its proposed members have much real experience of iron and steel production to guide them in the reorganisation they must attempt of a highly complicated industry and an industry, moreover, whose operations are likely to be partially dislocated by the terms of the Act. The decision of the Government amounts, in fact, to an astonishing reversal of its attitude under similar circumstances of last November. It is made all the more astonishing in that the terms of the Act themselves permit postponement; in that it hardly seems a suitable time to attempt to reorganise the industry when an additional load is certain to fall upon it as a consequence of increased defence expenditure; and in that at this time, affairs abroad make it desirable that unity rather than party differences should be stressed at home. Even our sober contemporary *The Times*, which is seldom so outspoken, has not hesitated to stigmatise the action of the Government as folly. Folly it seems to us.

At the end of last Tuesday's debate upon the subject in the House of Commons the Government survived by a majority of merely six votes. Little though a General Election seems desirable in present international circumstances, it would, perhaps, have been better had the Government been defeated. For now, as the consequence of the Government's folly, the Opposition may think it essential to challenge it at every opportunity. Just when a sane, sober and moderate policy was needed to allay party passions for the solution of the many technical, managerial, economic and labour problems that increased expenditure on defence must create, the acerbity of political party conflict has been increased and the stability of the Government made more uncertain. Nor has the future of the Iron and Steel industry been made any more certain. Since the Conservatives are pledged to repeal the Act even if the vesting day be past, a decision upon the nationalisation of the industry still rests where, despite a General Election, it has rested since last November—in the hands of the electorate.

SIMPLIFICATION IN INDUSTRY

THE "Group" appointed by the Anglo-American Council on Productivity to study the subject of "simplification" stated its conviction forthrightly in a first report, issued after its return from America, that in Britain "there are few, if any, firms which cannot benefit from simplification, whether applied to materials, equipment, components, or final production." Its second report was recently issued. That report which is primarily concerned to review the progress so far made in British industry, exhibits the same enthusiasm. It is right that it should do so. For the Group that produced it must necessarily conceive it to be its job to argue the case for simplification rather than to pay too much attention to those factors that may hold it back. Moreover, amongst less energetic managements, to whom in particular the report is no doubt directed, the existence of difficulties too often ensures that an object, even though it is admitted to be a good one, is not actively pursued. If such managements are to be encouraged to act it is necessary repeatedly to stress the advantages of simplification.

In fact, of course, simplification is less simple than it sounds and many factors have to be considered before that method of raising productivity can be wisely adopted. The advantages to firms and industries of "reducing the number of types and varieties made" are manifest enough. But unfortunately they cannot be gained without some loss. Simplification, by the very definition quoted above, necessarily means that the buyer is to be offered a narrower range of goods to purchase than he is accustomed to have available. It is true that if the work is wisely carried out the varieties excluded from manufacture are likely to be variations of the simplified product that have little real

value. Yet, unless the trouble is taken (at some cost) to educate it a market may well be lost through their exclusion. Moreover, once simplification has been adopted, once longer runs and higher productivity have been achieved, there is a real danger that a certain rigidity may creep in, and that a handicap may be imposed upon the introduction of improved and more up-to-date designs. That danger is not imaginary. For when a Group from the internal combustion engine industry visited America it found that though productivity was much higher there than here, design in this country was in advance of that in the United States. There is another point. It is true that simplification may have advantages even when the total output of closely similar articles is relatively small. But the advantages only become marked as total output grows. It is therefore in industries or factories that produce large quantities of similar goods that simplification can most readily be adopted. It is, too, under those circumstances that the objection of the market to its deprivation of variety can the more easily be overcome by cheapening the simplified range. Yet it is by no means easy in a developing industry or in an expanding factory, to determine at what level of production the advantages of some degree of simplification outweigh its disadvantages. All that can be said with certainty is that as output expands, so, with advantage, can simplification be carried further. It may be added, too, in that connection, that the process of simplification, and its sister processes of standardisation and specialisation, are by no means new to this country. They are processes that have been developing here over the last many decades; and even to-day, when in many fields the Americans have outstripped us in their application (being favoured by a more homogeneous and larger market) in certain industries, notably in the production of aircraft and the making of bolts, nuts and screws, we lead the world. Moreover, ever since the war ended, and as a direct consequence of high post-war outputs, engineering firms and industrial associations in this country have been particularly active in studying and applying the principles involved. They were doing so, as the report under discussion itself reveals, long before the Group concerned left for America.

We have no doubts about the productive benefits to be derived from simplification if it is wisely applied and the consumer is adequately consulted. On that point we are at one with the Group. But we are doubtful of the value of attempting to apply American experience of the principle to industries in this country which may, indeed, be producing goods of the same general type, but which are, in fact, supplying them to meet the demands of markets very different in character. In our view, therefore, this second report of the Simplification Group, a report which sets out to reveal "the steps which are already being taken by British industry towards simplification," is likely to be more valuable than the first, which related to American practice. For by showing what some British firms and industries have found it advantageous to do it may the better encourage other British firms and industries to do likewise. But there! We do not even disagree with the Group upon that point. For the Group itself remarks in the Foreword to its report "such an account may be even more stimulating to further action than the record of American experience."

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

ENGINEERS AND ÆSTHETICS

SIR,—In the August 25th issue of THE ENGINEER, you have said in the leading article that "engineers, of course, malign themselves when they suggest that they have little understanding of æsthetics." Being an engineer myself, may I be allowed to disagree with your statement?

However much I should like all of us to be alive to the æsthetic qualities of the engineering products, I must say that judging from personal experience the appreciation of visual art seems to be far less widespread among engineers than could be desired. Let's admit it—how often does one hear prominent—or, perhaps, even not quite so prominent—members of our profession seriously discussing problems connected with painting, sculpture or the ballet? And without some rudimentary knowledge of these subjects how can we judge the visual and æsthetic qualities of any engineering product? Undoubtedly, there are great people among engineers who are fully alive to the artistic problems of our day, but are they not the exception rather than the rule?

The latest, and perhaps the most glaring, example of indifference displayed by some engineers towards artistic aspects of their work is the apparent lack of interest in the architectural design of buildings for the Festival of Britain. Surely this would be an ideal meeting-place for artists and engineers to exchange ideas and try to appreciate each other's point of view!

May I suggest that my objection to the optimistic tone of your article could be further supported by recent reports of various educational bodies sounding the alarm against excessive specialisation in universities and technical colleges (see a number of leading articles in the volume of *Nature* for 1949). In all these cases the addition of subjects covered by the general term "Arts" has been recommended as a remedy.

P. A. LINDSAY, Ph.D., B.Sc. (Eng.).

London, W.14, September 1st.

THE SCIENTIST AND THE ENGINEER

SIR,—Of recent years the scientist has made spectacular progress and not a little of this he attributes to his penetration of the fundamentals of nature. In a manner of speaking his arguments border upon astrology and religion, and they sound strange in the ears of hard-headed engineers. By comparison the efforts of the engineer seem empirical, straight-jacketed and rule-of-thumb.

There must be some engineers, however, like myself, mathematically equipped to follow the voluminous writings of modern science, who find themselves unconvinced and many must feel that the time has come for the pendulum to swing back to the old fashioned and less spectacular logic.

Now the scientist constantly emphasises that the microscopic differs logically from the macroscopic. By this is meant that the logic underlying a sequence of events of a fundamental particle is different from that of particles acting in bulk.

I accuse the scientist, however, of falling into his own pit and issue a challenge that he cannot deny that the much-talked-of quantum arises only when he concerns himself with waves from a bulk "n" of elementary radiating bodies, e.g., atoms, and assumes that the quantity of radiation is "n" times that from one. Having found, for example, that the radiation from a surface is proportional to the area exposed, a macroscopic law, he then falls into the trap of assuming that the radiation from fundamental vibrating particles follows the same rule, a microscopic law. This error was made originally by Planck in his well-known investigation on radiation. Not even the wave theory itself, however, can accept this simple addition theorem. If two elementary vibrators are vibrating at a given amplitude in the same direction, say, north and south, but are 180 deg. out of phase with each other, the amount radiating out into the surrounding medium will be very much less than twice that from one source acting alone if the distance apart of the vibrators is small compared with the wave length. The vibrating molecules on a radiating surface are very near together compared with the wave length of visible light.

The scientist asserts that an individual quantum can only operate one individual vibrator and accordingly excite only one spot on an interference pattern. Clearly on this account and because the addition law is in doubt, the scientist cannot deduce a microscopic law from wave experiments which are of necessity macroscopic in every feature.

To me, one brought up in the engineering school, the physicist has not proved his case. As far as evidence goes the quantum and its associated jargon is no more than empirical correction necessitated through mixing up the microscopic and macroscopic. Eddington mentioned interference when discussing Planck's work. Should we not, therefore, rename Planck's constant, Eddington's interference factor and relegate the quantum to empirical status?

W. L. COWLEY

South Farnborough, Hants,
September 1st.

STANDARDISATION OF ENGINEERING PUBLICATIONS

SIR,—With reference to Mr. Wootton's letter which appeared in your issue of July 14th, we should like to point out that this Institution has published B.S. 1311, Sizes of Contents Arrangement for Manufacturers' Trade and Technical Literature (Building Industry), as well as B.S. 1413, Book Sizes and Dating of Books.

We appreciate that these two standards do not fully answer Mr. Wootton's problem since they do not relate to periodicals. We should nevertheless be grateful if we could use your column to bring them to the notice of the manufacturers of whose catalogues the complaint was made.

P. GOOD, Director

London, S.W.1, September 1st.

[Copies of the standards are obtainable from the Institution, price 1s. each.—ED., THE E.]

Technical Reports

Index of Publications of the Road Research Laboratory. D.S.I.R. London: H.M. Stationery Office. Price 1s.—The work of the Road Research Laboratory has been described in many publications, ranging from official reports issued by H.M. Stationery Office to papers contributed by members of the staff to learned societies and the technical Press. All these publications, since the inception of the Laboratory in 1933, until the end of 1949, have been recorded in this index, which includes brief summaries of the contents of the longer official reports and lists all other publications by the staff of the Laboratory. It includes conference papers and articles, giving, where applicable, references to "Road Abstracts," so that summaries of the papers may be consulted. A comprehensive subject-index of titles enables all the publications on a particular subject to be found easily.

Literature

Mathematics and the Imagination. By EDWARD KASNER and JAMES NEWMAN. London: G. Bell and Sons, Ltd., 6 Portugal Street, W.C.2. Price 15s.

HARDY, in "A Mathematician's Apology," divides mathematics into two classes, which he calls "real" and "trivial." The former he describes as the mathematics of Whitehead; the latter as the mathematics of Hogben. The authors of "Mathematics and the Imagination" are mathematicians and they have written a book which, in the main, falls into the first of Hardy's classifications. This does not mean that it is an advanced book and for mathematicians only. Although difficult in patches, it is well within the grasp of the average intelligent person who has no particular knowledge of mathematics. The engineer will be among the many who will find it of absorbing interest.

In the first chapter there is an introduction to the vocabulary of mathematics, where everyday words, such as "turbine," have been adopted as mathematical terms which have little relation to their normal meaning. Most readers will meet two new words, "googol" and "googolplex," which have been coined to denote two very large particular numbers. The fundamental difference between very large numbers—such as the total possible number of moves in a game of chess, or the number of electrons in the universe—and infinity is very carefully considered. It is felt that the authors having once made their point give too many examples in explanation.

In the discussion of the infinite class of numbers—transfinite numbers as they are called—and transcendental and imaginary numbers, the reader is given his first insight into the methods of real mathematics. One example is Cantor's proof that the rational fractions form a denumerable infinite sequence, that is, are countable in the same way as the infinite series of integers. One is warned that "the going is tough," but its comprehension is within the average reader's grasp, although perhaps not at the first time of reading. It is brought home how this type of proof differs from the proofs of "school" mathematics. As would be expected, considerable attention is given to π, and the classical problem of squaring the circle is considered. Mention is also made of the other two problems of the trio, duplicating the cube and trisecting an angle. When one comes to the second of the important transcendental numbers, e, the average reader and definitely the engineer, will be on home ground for a good deal of the way. For many, the properties and use of logarithms are commonplace and, in this part of the book the paths of real and trivial mathematics have for a moment coincided. This is also true to a certain extent for the treatment of i. It is paradoxical that, to this reviewer at least, the treatment of the imaginaries requires the least use of the imagination. In concluding their discussion of i they reproduce, but do not explain, the famous and important formula: $e^{i\pi}=-1$. They might well have recorded the unimportant but no less peculiar result that i^i pounds sterling is approximately four shillings and twopence.

The chapter on non-Euclidean geometry takes one away from "school" geometry and provides the authors with an opportunity for dealing with the idea of a fourth dimension.

To include some mention of mathematical puzzles and problems the authors have been obliged to select and condense from a vast field. Their method has been to choose typical examples and strip them down to their mathematical essentials. They have included such famous problems as ferrying people across a river under specified conditions and the arrangement of persons in a circle for the elimination of a specified class, when every nth person is removed. Of the well-known games which can be reduced to a mathematical solution mention is made of the "Tower of Hanoi," —transfer of discs from one peg to another via a third—"Nim"—game with piles of matches—and "le Jeu de Taquin"—box of fifteen numbered bricks with one empty space. The chapter on problems contains a few connected with the theory of numbers, and concludes, fittingly, with Fermat's Last Theorem.

Three rather different subjects are dealt with in the same chapter entitled "Paradox Lost and Paradox Regained." The first contains propositions which are strange but true; the second gives examples of some arithmetical and geometrical fallacies; the third deals with what are called logical paradoxes. A book of this type might well have dispensed with the second subject. Proofs that 1 equals 2 and that parallel lines appear to meet belong to the realm of popular mathematics. The logical paradoxes are more concerned with philosophy than with mathematics but they are none the less worthy of inclusion.

Probability is in the first place considered from a philosophical viewpoint with a critical assessment of what it actually means. The calculus of chance, which is dealt with afterwards, gives some of the theorems and types of examples that one would meet in an algebra textbook. The needle problem, with its solution of $2/\pi$ as the probability of success, serves to remind one that the subject is mathematics and not just algebra. An appendix to the chapter shows the application of probability to the Kinetic Theory of Gases and to Statistics.

To the average engineer topology is probably not a familiar branch of mathematics. The electrical engineer may have touched upon it with the general application of Kirchoff's Laws, but that is all. Thus, to many, the chapter on "Rubber-Sheet Geometry" will introduce entirely new conceptions and for that reason it is one of the most interesting chapters in the book. It is astonishing to learn that the classical problem of cartography, namely, that only four colours are both necessary and sufficient to colour any map so that adjacent countries have distinguishing colours, has not been proved.

If to the engineer topology is the least familiar branch of mathematics, then the calculus is probably the most familiar. To engineers and to many others the chapter on this subject is bound to contain a great deal that is elementary. To the uninitiated it is doubtful whether the detailed treatment of finding maxima and minima and the first and second differential coefficients will appeal. It might well be relegated to an appendix. There is an appendix which presents out-of-the-ordinary material in the discussion of the "Snowflake Curve" which is shown to have an infinite perimeter with a finite area and other pathological curves.

In an epilogue the authors pose the question "What is mathematics"? They contend that it is not merely a process of cold reasoning and deduction but the exercise of creative intellect in which imagination plays an essential and important part. Hence the title of their book. They write throughout in a light, easily readable manner, leavened with many historical anecdotes, some not without humour. The footnotes at the end of each chapter amplify the contents and give references, and there is a descriptive bibliography which gives the reader an introduction to books on related subjects. The authors' claim that they have presented snapshots is true, but so large a field is surveyed that by most readers some fresh views will be discovered. Some may find passages in the book which will tax their powers of comprehension; to others some of the material will seem elementary. However, the difficult sections have been explained with great lucidity and one will obtain much satisfaction once their meaning has been grasped.

SHORT NOTICES

Engineering Workshop Design. By H. Binns. London: The English Universities Press, Ltd., Warwick Square, E.C.4. Price 7s. 6d. per vol.—The first of these two volumes has been written primarily for the apprentice with a view to guiding him in the execution of simple detailed drawings and sketches in orthographic, isometric, oblique or pictorial projection drawings received from the drawing-office. Brief mention is made of drawing instruments, lettering and types of lines used and a few pages are devoted to elementary geometry. The book is then divided into sections dealing with various types of projection arranged in the form of exercises for the apprentice. Volume II is intended to be used as a continuation of the previous volume and is, therefore, more advanced in the drawing exercises, which deal mainly with tools, jigs and fixtures to familiarise the apprentice with these important components. Both these volumes are well illustrated, and in their field should be of much value to the apprentice.

The Rigid Frame Bridge. By A. G. Hayden and M. Barron. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 50s.—The third edition of this work, written by two American consulting engineers, has, as the principal addition to the earlier editions, a simplified method of analysis for skewed frame bridges. The authors state that the design of the single-span skewed frame bridge is almost as easy by this method as the design of the unskewed structure, and that the design of the double-span skewed frame bridge is quite simple and can be easily grasped by designers and students. The book outlines the relevant theory of analysis of statically indeterminate structures, and develops at length its application to the construction of short-span reinforced concrete and structural steel bridges.

BOOKS RECEIVED

Gas Welders' Tables and Data. Edited by E. Molloy. London: George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Price 5s.

Theory and Design of Inductance Coils. By V. G. Welsby. London: MacDonald and Co. (Publishers), Ltd., 19, Ludgate Hill, E.C.4. Price 18s.

Rinehart Mathematical Tables, Formulas and Curves. By Harold D. Larsen. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 15s.

British Non-Ferrous Metals Directory, 1949. London: Metal Information Bureau, Ltd., Birkett House, 27, Albemarle Street, W.1. Price 10s.

Engineering Economics: Book II, Factory Organisation and Management. By T. H. Burnham and D. H. Bramley. Sixth edition. London: Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 15s.

The S.B.A.C. Flying Display and Static Exhibition

No. III—(*Continued from page 273, Sept. 15th*)

THE Static Exhibition of the S.B.A.C. Show was this year composed of 190 stands, occupying 67,500 square feet, and was enclosed by what has been claimed as the largest canvas structure to be erected in this country.

The nature of many exhibits brought into sharper focus the engineering problems attendant upon flight, in the altitudes and speed ranges now rendered accessible by the advent of the gas turbine. One was able to appraise the response which the engineer has made to incessant demands for improved and wholly new auxiliary equipment, in which the power per unit weight, overall compactness and reliability are invariably critical factors in its design.

REFUELLING IN FLIGHT—GLOSTER "METEOR" AND THE AVRO "LINCOLN TANKER"

Significant amongst this equipment on show were the several systems of power-operated flying controls, distinguishable mainly to the extent by which power supplements the operation. The increasing weights and speeds of aircraft during recent years have made necessary the introduction of equipment which, whilst in no way removing from the pilot the essential "feel" of a machine, provides an effective means of imparting power assistance to manœuvre the aircraft. On failure of the power supply control reverts to a fully effective manually operated system. In other cases, where the control hinge moments are of such a magnitude as to be beyond even emergency manual operation, the complete power operation of controls is a minimum requirement, and systems incorporating duplicated hydraulic jacks or hydraulic screw jacks have been installed.

Amongst the equipment of the former kind shown at Farnborough was the "Hydro-Booster," made by Fairey Aviation, which has been designed to provide a simple, compact and self-contained power-assisted unit to reduce the manual effort required to actuate the controlling surfaces of an aircraft. This unit weighs only 5 lb or 9½ lb when fitted with a pilot's "feel-back" linkage. It can be readily fitted in new designs of aircraft and adapted to a majority of the control systems in the very restricted wing compartments of existing machines.

With this unit fitted, aircraft control is stated to be smooth and free from noticeable backlash, movements of the control column are immediately responded to, a variable percentage of control load feel is provided, and the self-centring of the pilot's control remains unchanged. The booster can be cut in or cut out at will by the pilot and it is at once disconnected in the event of hydraulic failure.

In this unit the main power element consists of an orthodox hydraulic jack operated through an integrally mounted control valve. This valve is the main feature of the unit and is of the high-precision slide type, with negligible dead movement and a very low operating load. The small amount of valve dead movement prevents control backlash and the low operating load of the valve gives adequate self-centring to the unit.

When the unit is disconnected aileron control is effected through a series of links to which the power jack is directly connected. To engage the booster, pressure fluid is admitted through the pilot's selector to a small hydraulic jack trunnion mounted on one of the levers. This jack engages a locking pawl, which couples the main power jack to the aileron control linkage through a load reducing linkage. With the unit engaged and receiving power assistance from the booster the pilot, in effect, provides the controlling medium. As the booster reacts continuously to the control surface load, the pilot constantly applies a fixed proportion of such load on his control column.

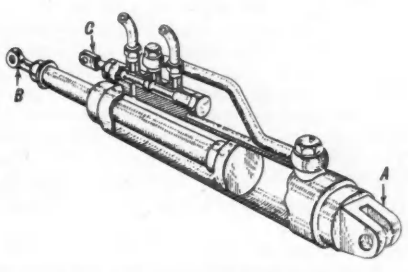
The Lockheed "Servodyne" unit for power-assisted controls, which is made by the Automotive Products Company, Ltd., is fundamentally a hydraulic jack with an integral valve. This unit, a diagram of which is reproduced on this page, is installed with the ramrod end *A* of the jack anchored to a fixed point in the aircraft structure, the jack body *B* being connected to the operating rod for the control surface. The pilot's control is connected to the valve piston *C* of the jack.

In the jack the hydraulic pressure is maintained constantly in the small or annular area on the ramrod side of the piston. By movement of the piston valve through the pilot's control, the head of the cylinder is connected to either the pressure fluid line or the header tank. It will be seen that when pressure fluid is admitted to both the small and large areas of the cylinder simultaneously the ramrod will move outwards. When the large area at the head of the cylinder is connected to the header tank the ram is moved inwards by the pressure fluid at the small end. By this simple arrangement the valve mechanism has only to allow fluid to enter or escape from one side of the jack when power-assisting the control. By eliminating the more usual change-over of fluid from one side to the other of the ram in this design valve, complexity and lag in operating is avoided. The makers claim that by having a constant pressure in the jack the "give" experienced with dead fluid is eliminated.

The lapped plunger valve *D* is contained in a sleeve of similar material and the assembly is insulated from direct contact with the surrounding body to prevent any distortion being transmitted to the sliding surfaces and to permit free movement at low temperatures. With all this class of power-assisted control equipment the use of mass balanced control surfaces must be retained.

A duplicated system of hydraulic screw jack power-operated control surfaces was exhibited by H. M. Hobson, Ltd., of Wolverhampton. This system is a particularly significant development, for in providing a powered control with a sufficient degree of irreversibility and rigidity the mass balancing of control surfaces can be eliminated, except in extreme cases where this would involve excessive power requirements. The fact that precise aerodynamic control balance is no longer necessary has not only simplified control design problems, which had previously been the cause of much development flying of prototype aircraft, but leads to a considerable reduction of weight.

The screw jack is operated by an electrically driven hydraulic pump with a maximum operating pressure of 3000 lb per square inch. The screw is designed to provide a mechanical efficiency of 65 per cent and irreversibility under load is maintained by the pump. The pump develops a constant power output when working under different pressure heads and can thus provide a low rate of control extension against heavy forces at high speed and inversely at low speeds. The rate of working per control surface is often of the order of several horsepower. It is essential with non-balanced control surfaces that the jack should be irreversible and therefore as rigid as any other component of the airframe. The use of hydraulic jacks was consequently unsatisfactory because of the compressibility of the total fluid contained in the jack; the compressibility of the relatively smaller swept volume of the pump per

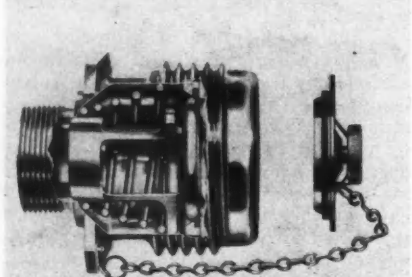


THE "SERVODYNE" POWER ASSISTED CONTROL UNIT

revolution is negligible by comparison. The choice of an electrical drive to the pump was dictated by the risk of fluid icing in those parts of a hydraulic circuit otherwise too distant to benefit from the self-heating effect of the pump. Only the power units are duplicated, it being unnecessary to provide for the failure of the purely mechanical parts. A safety "breaking" link device ensures that a faulty pump is rendered inoperative should a "runaway" control condition develop.

Further complications which affect high altitude flight and the high rates of climb now attainable are the serious petrol losses due to boiling and the decrease of fuel viscosity at the low temperatures experienced.

Fireproof Tanks, Ltd., had on show an improved fuel tank designed to overcome these effects. Hycatrol flexible fuel tanks are manufactured from synthetic rubber sheeting reinforced on the outer surface with a special nylon fabric. The nylon is designed to break at low shock loadings, and to allow the sheeting to stretch and conform to the distorted shape of the tank bay under heavy landing or crash conditions, and to remain petrol-tight. These cell tanks are pressurised



SECTIONAL VIEW OF THE MALE FLANGED CONNECTOR AND CAP

with air, exhaust gases or nitrogen to maintain the requisite petrol vapour pressure. The tank is reinforced with special skin harnesses, which serve also to help withstand the pressure differential created by the restriction of the air vents to the ingress of air during rapid descents. It is claimed that the material retains its mechanical properties in the range of −60 deg. to 50 deg. Cent. The tank can also be lagged with a new lightweight material so that a temperature can be maintained whereby the viscosity of the fuel does not impede its flow. The company have also developed a glass cloth fireproof covering for welded aluminium tanks to which it is bonded with a fireproof lacquer.

Sir George Godfrey and Partners, Ltd., had on display equipment for pressurising and conditioning cabin air at altitude and for other purposes. Due to fuselage skin friction at high speeds in close support combat aircraft, it has become necessary to supply cool air to the cockpit. A cold air unit designed for this purpose has an air mass delivery of 8 lb to 12 lb per minute and operates at speeds up to 60,000 r.p.m. Its compactness can readily be appreciated by the fact that it can be totally enclosed by a cylinder 7⅝in diameter by 5½in long and weighs only 9½ lb. Pressure air is bled from the jet turbine and delivered to the centrifugal compressor of the cold air unit, which is mounted coaxially with a "reaction" turbine which drives the compressor. After expansion in the turbine the temperature of the air drops sufficiently for it to act as a cooling agent to be ducted to the cockpit. A similar unit, the A.C.R.12, has been developed for cooling cabin air and has been installed in the Avro Canada "C100." This unit is supplied with pressure air from a Marshall cabin supercharger type "3/40/25," the air having first passed through a silencer and a primary air-to-air heat exchanger, where it is cooled. Leaving the compressor, the air is passed through a secondary cooler before entering a "reaction" turbine. The cooled expanded air is then ducted throughout the cabin. A Marshall cabin supercharger, type "15 Mk. 9," in conjunction with a cold air unit, provides a supply of air at any desired temperature and pressure. Compression is obtained in two stages with intercooling by mounting two Rootes rotary displacement superchargers coaxially which rotate at 12,000 r.p.m; the design permitting the same rotor diameters, but providing shorter rotor blading for the second stage. This type of combined unit has been extensively adopted on present airliners.

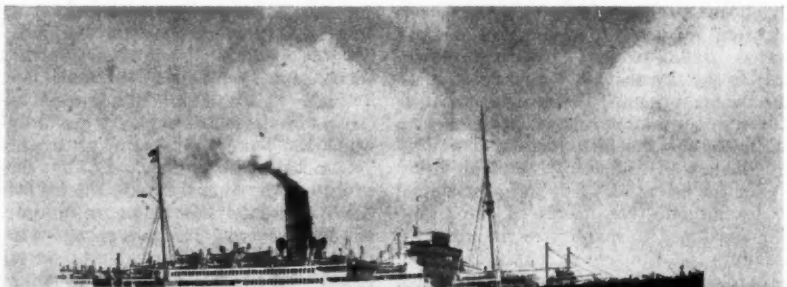
The fuel tankage required by aircraft using gas turbine propulsion has reached such proportions that gravity refuelling methods are no longer adequate, and the Lockheed-Avery pressure refuelling equipment exhibited by Automotive Products, Ltd., has been developed to accelerate this process.

Connection on to the supplying source is made through Lockheed-Avery pressure fuelling connections which enable fuelling to take place from below the level of fuel in the tank. Valves in both half connectors allow the connection and disconnection to take place without the loss of fuel and while the supply line is under pressure. The male connection fitted to the fuel tank is shown herewith There is no connection open to the atmosphere during the refuelling, except through the vent connections on the aircraft itself. Fuelling rates of over 80 Imperial gallons per minute are practical when using the existing pump pressures. Much higher rates will be employed when larger pumps are available.

The rate at which jet-propelled aircraft consume fuel in addition to their restricted fuel capacity has made urgent the need to extend their duration by flight refuelling methods. The British "drogue and probe" system has been developed by Flight Refuelling, Ltd., and flying demonstrations were given at Farnborough of the complete process from interception to breakaway. Our photograph shows the Gloster "Meteor" jet fighter and the Avro "Lincoln" tanker during the refuelling process. A suitable length of pressure hose is winched out from the tanker, and to the end of the hose, which trails horizontally, is fitted a cone-shaped metal drogue. The "Meteor" formates upon the tanker until the hollow probe attached to its nose enters the drogue. By temporarily accelerating, the probe penetrates to the throat of the drogue and an automatic mechanical union is effected from when the fuel flow of 120 gallons per minute commences. The union can be broken by either machine.

R.M.S. "Scythia"

ON September 14th the 20,000-ton Cunard liner "Scythia" left London for Quebec to take her place in the company's Canadian service and before sailing we were able to inspect the vessel at the invitation of the Cunard Steam-Ship Company, Ltd. In common with most large passenger liners, the "Scythia" served as a troop transport during the war and after release from this duty the ship underwent a limited refit and then made a number of voyages carrying displaced persons from Europe to Canada. This work for the International Refugee Organisation has meant a considerable delay in the vessel taking up her normal passenger-carrying duties and it was in November of last year that she was sent to the Clyde to be completely reconditioned by John Brown and Co., Ltd.



R.M.S. "SCYTHIA"

Externally, the vessel, which has a length between perpendiculars of 600ft, a breadth of 73ft 6in and a depth of 45ft, presents practically an unchanged appearance, but internally there has been a transformation. Originally the ship, built by Vickers, Ltd., in 1921, was designed to carry 2206 passengers in three classes; 337 first-class, 331 second-class, and 1538 third-class, and this space has been now laid out to afford comfortable quarters for 248 first-class passengers and 630 tourist-class passengers. The spacious first-class cabins are decorated in four different schemes, and are fitted with two or three berths, many having private bath rooms, as originally arranged. Tourist accommodation consists mainly of two-berth cabins and an adequate number of cots are supplied for young children.

On the upper promenade deck the first-class public rooms have been redecorated and additional amentities incorporated. The garden lounge on the port side has been retained,

while the starboard side space has been converted to a cinema, seating nearly 150 and being available to travellers in both classes, as is also the well-equipped games room. A total of seven public rooms are available for the tourist passengers, the smoking room on the main deck being entirely new. Both the first-class and tourist restaurants extend the full width of the ship, the first-class

TOURIST CLASS RESTAURANT

room seats 265 and the main tourist room has accommodation for 272, this number being increased by the inclusion of a pleasant annexe seating seventy-four. The young passengers in each class have not been forgotten, there being two children's play rooms well stocked with toys for their entertainment.

The main propelling machinery for the ship as built consist of two sets of Brown Curtis turbines, driving the propellers through double reduction gearing. The power developed is 12,500 s.h.p., with propeller revolutions at 80 r.p.m. Extra nozzles in the h.p. turbines raise the power to 13,500 s.h.p., to give the vessel a speed of 16 knots. Contraflow condensers are underslung on the l.p. turbines and can maintain a vacuum of 28½in against a barometric pressure of 30in with the sea-water temperature at 65 deg. Fah. Steam is supplied at 220 lb per square inch and 200 deg. Fah. of superheat by three double-ended and three single-ended boilers of the multi-tubular return design, fitted with smoke-tube superheaters and working under forced draught. The whole of the machinery has been overhauled and the necessary replacements made and, with the exception of the gearing, which has been renewed, all the main fittings are fit for further service. The boilers have received some detailed attention and the regenerative system has been improved by the inclusion of a Weir's deaerator and a lift pump.

Completely rejuvenated by John Brown and Co., Ltd., the "Scythia," although nearly thirty years old will, no doubt, give many years of useful service on the run from London to Quebec.

The Avro "Ashton" High-Altitude Research Aircraft

INTENSIVE research has been conducted within recent years into the problems of high-speed flight at great heights — factors which form the governing conditions for optimum cruising efficiencies in jet-propelled aircraft. These investigations have hitherto been carried out in small combat aircraft to which they were confined, because these were the only machines then capable of high speeds at altitude. As the scope of this research increased it became inconvenient and often impossible, within these small aircraft, to install and inspect the necessary flight reporting instruments involved. Such considerations led to the development by the Hawker Siddeley group of an aircraft with a sufficient endurance which would enable the crew and engineers to inspect without restriction or discomfort a maximum amount of research equipment at heights in the region of 40,000ft. This aeroplane, named the "Ashton," was made by A. V. Roe and Co., Ltd., and first flew on September 1, 1950. The "Ashton" has the conventional lines of an airliner and a fuselage similar in construction to the "Tudor" aircraft made by this company.

This aircraft is a low-wing monoplane with a squared fin and rudder and a tricycle undercarriage, and has a span of 120ft, length 89ft 7in and maximum fuselage diameter of 11ft. Power is provided by four Rolls-Royce "Nene" turbo-jet engines and the normal crew complement comprises captain, co-pilot, flight engineer, navigator and radio officer.

General Construction

The "Ashton's" fuselage is of orthodox construction, embracing lateral formers spaced and stiffened by longitudinal stringers and, with the exception of the nose forward of the cockpit, the fuselage is circular in section.

The basic main plane structure consists of front and rear spars spaced by aerofoil contoured ribs. A centre section main plane forms a root to which inner and outer plane sections are shackled on each side. Attached to the centre and inner planes are removable trailing edges. Landing flaps are hinged to each trailing edge section and two-piece ailerons are attached to the outer plane sections.

Synchronised dual flying controls are manually operated through the medium of push-pull rods. Each control surface has a manually operated trim tab, the controls for these, together with position indices, being located on the aft end of the engine control pedestal. Racks, pinions and cables are used in the tab control runs, and servo-tabs are fitted to each control surface. Automatic flight is effected through a Mark 9 (S.E.P.1) "Auto-pilot," which is an installation electrically controlled throughout.

All three units of the tricycle undercarriage have twin wheels. The nose wheel retracts into an unpressurised section of the fuselage nose and the main wheels into the engine nacelles. All units have a single shock absorber strut and when retracted are totally enclosed by mechanically linked doors. Strut operation of the nose wheel employs the Dowty liquid spring principle and main wheel shock absorption is effected by oleo-pneumatic action. The maximum steering angle is 35 deg. each side, and beyond this range castor action is obtained up to 170 deg. each side.

Power Plants and Auxiliaries

Twin Rolls-Royce "Nene" turbo-jet engines are mounted in single nacelles on each centre section of the main planes. A large detachable cowling at the front of each nacelle forms a common air intake to the engines, the thrust outlet being in the form of individual engine jet pipes passing below the main plane spars and terminating aft of the trailing edge. Engine separation in each nacelle is effected by a longitudinal fireproof diaphragm attached to the engine fire wall. A Rolls-Royce auxiliaries gearbox is mounted on the rear face of the fire-wall, drive transmission to this component being taken from a lateral universal connection from each engine wheel case. These joints drive a common shaft, beginning at the forward end of the diaphragm, which runs aft to the gearbox.

The gearbox-driven auxiliaries are arranged as follows:—Port gearbox: one 15 lb cabin supercharger, one 30 lb cabin supercharger, two Dowty hydraulic pumps, two Hymatic compressors; starboard gearbox: one 15 lb cabin supercharger, one 30 lb cabin supercharger, two Dowty hydraulic pumps. All four cabin superchargers are used for air conditioning purposes. If one of either pair of the engines fails the other will transmit adequate power to drive the gearbox. Each engine and each gearbox has its own independent oil system, the sumps for each component forming part of the basic structure. In addition to the normal gearbox supply a separate oil reservoir is fitted at the forward end of the longitudinal drive shaft.

The engine controls are fitted at the pilots' and engineer's stations. Located centrally between the pilots is a control pedestal incorporating four throttle levers; on the engineer's table are two quadrants, one for throttle levers duplicating those in the cockpit and the other housing four high-pressure fuel cock levers. These latter controls are used to stop the engines. Chains, sprockets and tie rods are utilised in the greater part of the control run, but at the engine end "Teleflex" cables complete the high-pressure cock circuit and operating shafts and levers terminate the throttle run.

The fuel supply is contained in eight flexible tanks, four to each main plane. For feed purposes the supply is divided into two parts, one side feeding the port engines, the other the starboard. A cross-feed cock, however, can be brought into operation to feed all four engines from one side, if necessary.

Each tank is fitted with an electrically operated fuel pump, and flow to the engines is governed by a low-pressure cock located in each supply line. With the exception of a drain valve, which is manually operated on the ground, all fuel system cocks are electrically operated from the engineer's station. Contents, pressure and flow gauges are also fitted on the engineer's panel.

Hydraulic and Pneumatic Systems

Undercarriage retraction, flaps operation and nose wheel steering rely on a three-pump, live-line hydraulic system for motive force. Undercarriage extension is by gravity, the up-locks only being released by hydraulic pressure.

If the hydraulic system fails an emergency air system can be brought into operation to release the undercarriage up-locks, assist in initial undercarriage extension and function the flaps; two ground-charged storage cylinders are used to contain the supply.

On the port side auxiliaries gearbox are two Hymatic compressors. These charge a pair of

pneumatic system storage cylinders which supply compressed air for the operation of main wheel brakes (double inflation bags), hydraulic reservoir and windscreen de-icing tank pressurisation, and water delivery to the crew's toilet. Pressure to the hydraulic reservoir is continuous.

AVRO "ASHTON" RESEARCH AIRCRAFT

CABIN AIR CONDITIONING

Flight at high altitudes without the aid of respiratory or heating equipment is possible due to the installation of a cabin air conditicning system. The system comprises four superchargers, which deliver outside air to the fuselage via coolers, silencers and controllable spill valves, after which the air is distributed to all parts of the cabin by underfloor and roof ducting.

The temperature rise during the compression stages is employed to warm the cabin and is controllable by throttle valves. Regulation of the pressure of air inside the cabin is effected by a discharge valve which opens and closes automatically to release excess air pressure. By this method internal cabin pressure can be set to remain constant at a predetermined figure. Air circulation inside the cabin is assisted by an electrically driven fan; waste air from the crew's toilet is discharged to atmosphere.

Before flight the internal cabin pressure and required temperature can be preset at the engineer's station. In the air the system will then function automatically, but can be adjusted to other pressures and temperatures as required. Maximum cabin pressure is 8·2 lb per square inch differential, which at 40,000ft provides an internal atmospheric pressure equivalent to that at 8000ft.

To prevent loss of air pressure when the cabin is inflated a sealing system is incorporated. Around all cabin doors and escape exits are inflatable rubber seals. Pressure seals are fitted where controls or piping pass out of the fuselage, and sealing compound is applied to all constructional joints. Air pressure for the inflatable seals is supplied from a foot pump.

DE-ICING AND MISCELLANEOUS SYSTEMS

Among the "Ashton's" miscellaneous systems are the following:—Windscreen and leading edge de-icing installations, a twin-cylinder oxygen system for crew members, and a single-tank cold water system. Windscreen de-icing is separate from aerofoil leading edge de-icing and employs air pressure for fluid delivery to sprays located in front of the windscreen. Leading edge de-icing, which utilises the T.K.S. principle of porous metal leading edge inserts, multi-cell pump and ice detector head, is controlled from the engineer's station.

Provision is made for fitting four 6kW generators, each driven by an engine wheelcase, which supply power for the electrical and radio services and also charge four 12V, 60Ah accumulators wired in series parallel. Voltage control is obtained by type "23" regulators, line voltage being maintained at 28V by a master regulator. A single-pole wiring system is used which utilises the aircraft structure as a negative return. A ground/flight switch is located at the engineer's station. "Pren" type cables are used for the greater part of the wiring system and breakdown points consist mainly of S.B.A.C. connection blocks. Ring and socket connection blocks are fitted at wing roots and spar constructional joints.

The radio officer controls h.f./m.f. main and auxiliary installations. "Marconator" radio compass and "Rebecca" Mk. 2: V.H.F. radio telephony and controllable beam approach systems are installed and are operated by the pilots. At the engineer's station is a main power switch used to control all radio and radar supplies. Flight conversation is effected through a Bendix intercommunication system.

Items of emergency equipment fitted in the aircraft include two inflatable dinghies, released manually or electrically (immersion switch); electrically operated engine and gearbox fire extinguisher system; roof and window escape exits; parachute exit.

Fire axes and hand-operated extinguishers are also provided and a decompression mechanism used to release differential cabin pressure if the need arises, is installed.

D.S.I.R. Tests on Surface Dressing

THE problem of rain spoiling surface dressing immediately after it has been laid is a serious one to road engineers. More than half the mileage of roads in this country is maintained by surface dressing; that is, by spraying a film of tar or bitumen on the road and immediately covering the film with chippings. If it rains soon after the laying of the dressing, water prevents the stone chips from sticking to the coated road. Traffic soon scatters the chips and makes ruts in the loose stone and the dressing has to be done again.

The Road Research Laboratory has carried out extensive experiments to develop an effective way of ensuring that freshly-laid surface dressings are not spoiled by rain. Fundamental studies of the physics of adhesion of the bituminous binders to stone surfaces in the presence of water were made, using various types of wetting agents mixed with the tar and tried out in surface dressings during summer and winter. All these tests produced poor results. It was then decided to treat the other surfacing material—the stone chips. The chips are normally stored on the roadside in piles ready for the work. The outside layer may be dry but the inside of each heap is generally wet even in fine weather, so that the stone scattered on the tar is normally wet. The wetness of the stone is no problem in fine weather during the summer, as the stone dries quickly when spread on the road and sticks to the tar. If, however, the atmosphere is humid or cold, the wet stone will not dry out and there is no adhesion. It was found that the water on wet stone is displaced if the stone is treated with creosote containing a "wetting" agent. This treatment enables the stone to stick to the tar immediately and water cannot later break this bond.

Of the materials tried it was found that a solution of creosote and cetyl pyridinium bromide was completely successful. The best method of coating the stone is in a large mixer, for instance, at a quarry, but for stone already dumped at the roadside a concrete mixer is more convenient. The surface dressing will then stay on the road no matter how hard or how soon it rains after the dressing has been laid. It is also possible to spray the solution on the top of the tar film before the stone chips are applied. This method gives good results although it is not quite so effective as using treated stone.

Both methods of treatment were tested in the rainier districts of the country. With the co-operation of road engineers, lengths of surface dressing were laid in Cornwall, N. Wales, the Lake District, Lancashire, Dumbarton and Lanarkshire. In each county sections of treated and untreated dressing were laid on the same day so that a good comparison could be made. The results confirmed that the treatment is effective.

The treatment, of course, adds to the cost of surface dressing, but only about a penny or three-halfpence per square yard. Since the expenditure on surface dressing each year is some £8 million to £12 million, considerable economy should, in fact, result from making the process more certain in spite of the increased costs.

Tyne Improvement Commission Centenary

THIS year marks the centenary of the Tyne Improvement Commission and, in commemoration of the event, a brochure has been published which pictorially illustrates the vast progress made in the development of the river. Systematic dredging has converted a fordable stream into a waterway which can take the largest ships afloat, there being 30ft of water at low tide. Mr. W. A. Souter, the chairman of the commission, in his foreword draws attention to the rise of the Tyne as a commercial port by comparing the annual revenue of to-day with that of 100 years ago and quotes the expenditure involved in the development, linking these figures with the small amount of debt to be redeemed. He also mentions the large amount of shipbuilding which takes place on the river banks and the importance of the river as a ship-repairing centre. Coal shipments are commented upon and Mr. Souter pays tribute to the contributions made by local municipal authorities and by private enterprise, particularly mentioning the proposed new dry dock and also the agreement to construct an ore-discharging quay. During this week the Commissioners entertained representatives of Continental and British shipping and there was a service in St. Nicholas Cathedral.

British Standards Institution

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1.

STANDARDISATION OF TAPER-ROLLER BEARINGS

The British Standards Institution, having just published a revision of B.S. 292: "Dimensions of Ball Bearings and Parallel-roller Bearings," has recently decided to commence work on taper-roller bearings. As is the case with other bearings, inch and metric sizes are in use in this country. The Lemon Committee of the Ministry of Supply drew particular attention to the necessity of reducing variety, and in the interests of simplification it was agreed in revising B.S. 292 to recommend that metric sizes only of ball and parallel-roller journal bearings be used in new designs. In the case of taper-roller bearings, however, the predominant usage has been reported to be in inch sizes. A sub-committee has been set up to examine the position and, as a first step, it has been asked to try to draft a systematic series of standards in the inch system in which the overall dimensions progress by regularly increasing steps.

The work of this sub-committee is at the moment quite exploratory and it is much too early to state that a British Standard for taper-roller bearings will be issued on the basis of any existing series or that it will be confined to either inch or metric sizes.

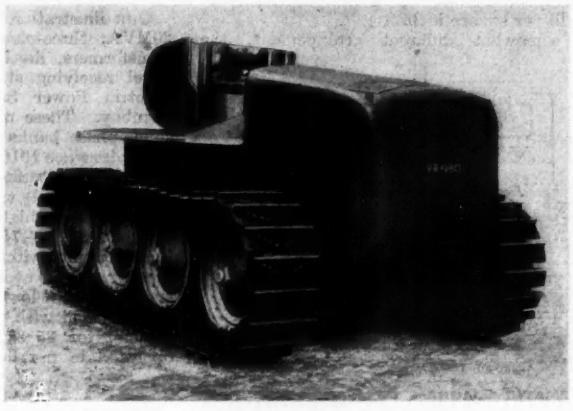
Diesel Shunting Locomotive Performance

Two 204 b.h.p., 28-ton diesel shunting locomotives just completed by the Hunslet Engine Company, Ltd., for the Algerian Railways, are being shipped to supplement the work of ten similar units built by the firm, which have been in service on the Algerian standard-gauge system for the past one to three years. Two further engines are to be supplied. These repeat orders are stated to be a result of the successful performance of the first batch of locomotives which have been operating with yard loads of from 350 tons to 400 tons, and at times, 500 tons. The ten original locomotives operate at five different centres in Algeria, some of them a long way from a main depot.

After being engaged in sixteen-hour-a-day, seven-day-a-week freight and passenger shunting service for twenty-two months, and covering some 20,000 miles, with indifferent driving, the first locomotive of the original ten was opened up for its first general inspection.

The inspection showed that the four-speed gearbox and its internal-tooth clutches, the straight-tooth gears and roller bearings, shaft brake, reversing bevels and jackshaft drive, were all in excellent condition and every part was put back without any attention. During the twenty-two months the locomotive had been in operation not a single part had been replaced, nor had the lid of the gearbox ever been taken off. The friction main clutch was relined with Ferodo during reassembly and a new disc plate put in.

The Gardner 8L3 oil engine of the locomotive was also in good condition. Its liners were still fit for some months' work before reboring would be required and there were practically no marks on the piston walls or wear in the ring grooves. Valves, cylinder heads, and piston crowns were in a remarkably good state and since the previous three-monthly inspection only a little softish carbon had been deposited on the piston crowns and the valves. The camshafts and valve gear showed no defect or measurable wear. None of the engine's big-ends or main bearings needed attention or replacement; water jackets and radiator surfaces were unfouled and uncorroded, and the crankcase and engine interior generally were clean.



PROTOTYPE HEAVY DIESEL TRACTOR

Heavy Diesel Tractor

We have received particulars of the heavy, continuous track type tractor now being manufactured by Vickers-Armstrongs Company, Ltd., which was announced a few weeks ago and briefly referred to in our issue of August 4th.

The machine, which weighs 32,000 lb, is driven by a Rolls-Royce diesel engine and is capable of developing a drawbar pull equivalent to 150 h.p. The overall dimensions are given as length 14ft 8in, height 7ft 3in, width 8ft 8in. We reproduce herewith an illustration of the machine.

In this tractor a heavy welded steel frame, carrying the engine and auxiliaries, is bolted to the main transmission casing. This form of construction, in addition to providing complete protection for the underside of the tractor, provides a rigid base for the attachment of front-mounted equipment. The weight of this assembly is distributed over the continuous tracks through four large steel wheels on each side of the machine. These wheels are mounted on a system of bogies, through the movement of which the track is allowed to conform to surface irregularities, whilst maintaining a uniform weight distribution. The adoption of this suspension system is claimed to permit relatively high tractor speeds over rough ground without discomfort to the operator or increasing the maintenance costs. By making the rolled steel track plates detachable, the width of the track can be altered to suit varying ground conditions. The track links are made from forged heat-treated steel and are connected by replaceable case-hardened pins and brushes, which are completely sealed.

The six-cylinder Rolls-Royce diesel engine has a bore of 5·125in, a stroke of 6in, providing a total volumetric capacity of 742 cubic inches. At the maximum governed speed of 120 r.p.m. the engine develops 180 b.h.p. and 150 h.p. at the drawbar.

Power is transmitted from the engine through a single foot-operated clutch to a constant-mesh gearbox, which provides six forward and three reverse speeds. The gears are engaged by dog clutches and all speed changes can be made whilst the tractor is in motion. The drive is then transmitted by helical bevel gears through multi-plate steering clutches and spur-reduction gears to the track sprockets.

The traction speeds at a governed engine speed of 1800 r.p.m., are 2·18, 3·21, 3·76, 5·6, 6·548, 9·73 m.p.h., respectively, and the three reverse speeds are 2·67, 4·59, and 8·8 m.p.h. Steering is effected by differential track braking, controlled by levers, which operate both a hydraulic clutch release and the track brakes. A separate pedal applies simultaneous track braking. Auxiliary power drives are available at the front and rear of the tractor, from which can be operated a wide range of control units, winch and hydraulic equipment, &c.

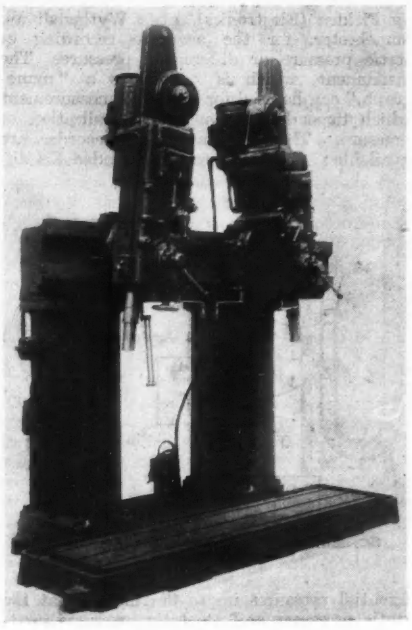
The drawbar has a ground clearance of 16in and a lateral movement of 35·75in and can be locked in a number of positions. The electrical equipment includes engine starter, a generator, and heavy duty battery which provides a 24V supply.

A Duplex Axle Drilling Machine

We reproduce herewith a photograph of a machine built recently by Kitchen and Wade, Ltd., Arundel Street, Halifax, for drilling and reaming king pin holes in commercial vehicle front axles.

In this double headed machine the two heads, right and left-hand, are independent, each being powered by a 5 h.p. motor. The drive is taken through a gearbox, which gives three spindle speeds, 180, 130 and 80 r.p.m. The spindles, which are 2in dia., are multi-splined from the solid in the drive part and increase to the noses, which are bored No. 4 Morse taper.

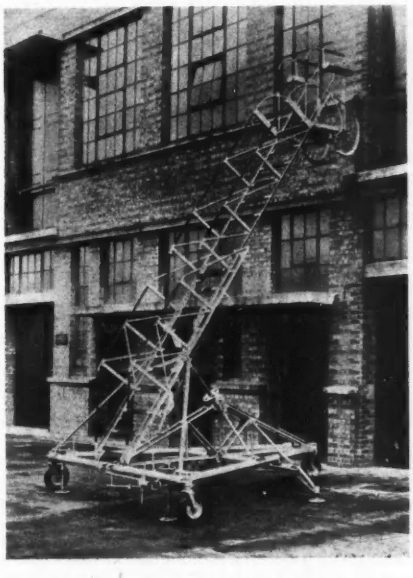
In addition to fine and quick hand motions to the 15in spindle traverse, three power feeds are provided 35, 60 and 95 cuts per inch, and an automatic trip motion is fitted. Each head can be swivelled 7½ deg. each side of vertical through a worm and quadrant and secure locking arrangements are provided for both this motion and the cross traverse. This type of machine is also made by the company with rising and falling tables.



DUPLEX AXLE DRILLING MACHINE

A Mobile Servicing Ladder

We have received brief particulars of a mobile extendible servicing platform, which is now being produced by Merryweather and Sons, Ltd., of Greenwich, London, S.E.10. This ladder was originally developed for use in servicing the Bristol "Brabazon" airliner and is now being made for other applications.

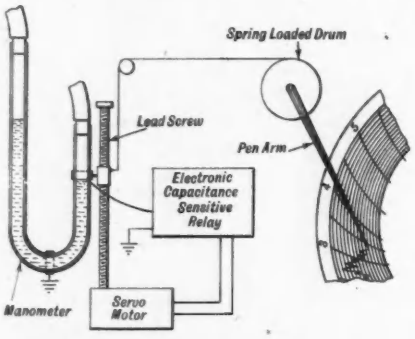


EXTENDIBLE SERVICING LADDER

As can be seen from the photograph reproduced above, the unit consists of a ladder, fitted with handrails and a working platform, mounted on a triangular tubular base. This base is carried on three castoring wheels and it can be raised on four quick-action screw jacks. The angle of the ladder can be adjusted through a screw-operated gear and it can be extended by means of a hand crank operated winch. The platform is adjustable for heights up to 32ft.

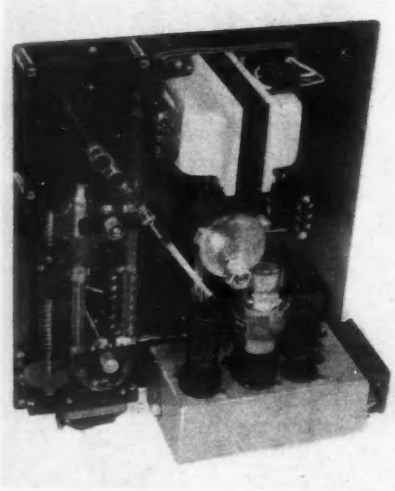
A Recording Manometer

THE accompanying illustrations show the general arrangement and principle of operation of an instrument, which has been developed by Fielden (Electronics), Ltd., Wythenshawe, Manchester, for the accurate recording of static pressure or differential pressure. The instrument, which is known as a "manograph," can be used for any fluid measurement which depends on manometric indication of pressure. Three forms of the recorder are available: the first two are intended for differential pressures up to 8in mercury at low static pressures and at static pressures up to 400 lb per square inch, respectively; the third form is designed for differential pressures as low as 2mm mercury at low static pressures.



SCHEMATIC DIAGRAM OF MANOMETER RECORDER

Our first diagram shows the basic principles of the instrument. Two metal rings encircle the manometer tube: the lower ring serves to "earth" the manometer liquid, while the upper ring is driven by a lead screw operated by a servo system, which ensures that the movement of the ring corresponds exactly with the movement of the liquid meniscus. Essentially, the input side of the servo system consists of an electronic capacitance-sensitive relay, which detects the change in capacitance corresponding to any movement of the meniscus. A corresponding electrical change is transmitted to the servo motor, which drives the lead screw and moves the ring up or down to restore its position relative to the liquid meniscus in the manometer tube. The movement of the ring is transferred to the pen mechanism as a measure of the pressure change. No electrical or mechanical contacts with the manometer liquid are involved in this method of measurement, which depends solely on the change of capacitance associated with a change in the liquid level.



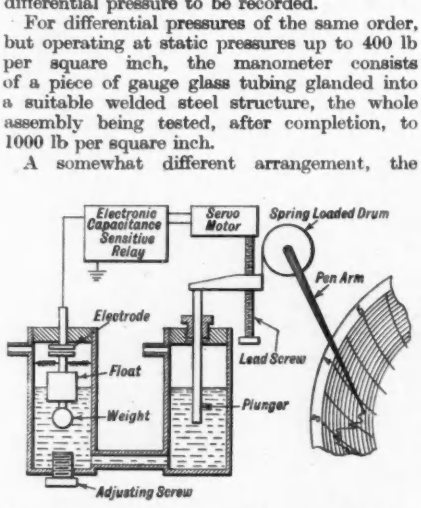
MECHANISM OF RECORDING MANOMETER

One of the photographs reproduced herewith gives a general view of the mechanism, including the servo motor, lead screw, manometer tube and pen arm on the left, and the electronic relay with its transformer on the right.

For differential pressures up to 8in mercury, at static working pressures close to atmospheric, the manometer takes the form of a glass "U"-tube, and connections to the pressure pipes are made by rubber tubing. The manometer liquid can be mercury, water or any other conducting liquid, depending on the differential pressure to be recorded.

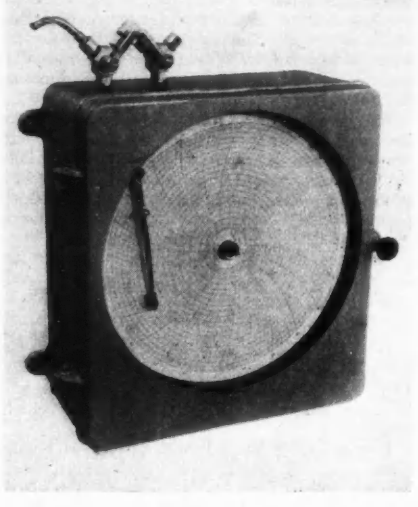
For differential pressures of the same order, but operating at static pressures up to 400 lb per square inch, the manometer consists of a piece of gauge glass tubing glanded into a suitable welded steel structure, the whole assembly being tested, after completion, to 1000 lb per square inch.

A somewhat different arrangement, the elements of which are shown in our second diagram, is used for small differential pressures, below ½in w.g. The manometer consists of two comparatively wide-bore tubes, in one of which there is a light metal float, which is kept away from the sides of the tube by fine ligaments. A flat electrode is mounted in a fixed position directly above the float and approximately 0·005in away from it.



SCHEMATIC DIAGRAM OF MANOMETER FOR SMALL DIFFERENTIAL PRESSURES

If the float rises or falls due to a change in pressure, there is a corresponding change in capacitance between the float and the electrode. This change is detected by the electronic relay and passed on to the servo motor, which, in turn, operates the lead screw and moves the plunger in the right-hand limb of the manometer until the float in the left-hand limb is restored to its original position. The movement of the plunger, which is transferred to the pen mechanism, is then proportional to the change in manometric pressure. In this form of instrument the liquid can be water or any other low specific gravity medium.



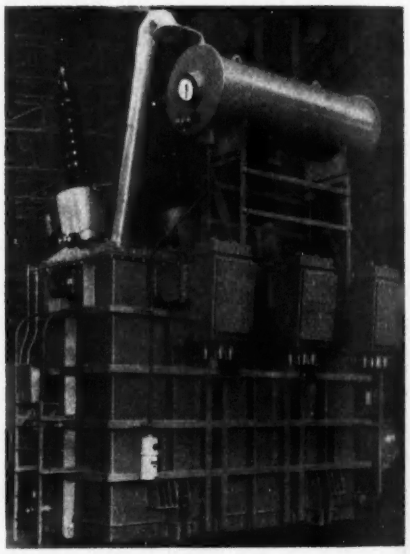
"MANOGRAPH" IN WALL MOUNTING CASE

One of the photographs reproduced herewith shows the general appearance of the manograph, housed in its cast aluminium splash-proof case, which is arranged for wall-mounting. Standard pipe connections are used for fitting the required pressure pipes and the instrument is provided with isolating and equalising valves. Excluding pipe connections, the manograph case measures 13¾in by 15in by 7in. Electrically the instrument is operated from the normal 200–250V, single-phase, 50 c/s mains, the power consumption being 35W.

Water-Cooled Outdoor Transformers for India

OUR illustration shows one of a number of 20MVA, three-phase, 100/6·6kV Hackbridge transformers, destined for installation at the Parel receiving station of the Tata Hydro-Electric Power Supply Company, Ltd., in Bombay. These units are to replace existing single-phase banks at Parel, which have been in service since 1916.

They will operate at the receiving end of a 115kV (nominal) transmission system and are provided with high voltage tappings of ±2½ per cent and 5, +7½ and +10 per cent, selected by off-circuit switch, to permit voltage adjustment. As, however, the existing transmission system is on a lower voltage, the transformers are provided with a full capacity high voltage tapping for 85·8kV, on which they can be operated in parallel with the existing transformer banks, pending changeover to the higher voltage system.



WATER-COOLED 100/6·6KV TRANSFORMER

They are outdoor units and will be subjected to relatively severe operating conditions, since, at Parel, ambient temperatures are reached of up to 45 deg. Cent. in the sun, while during the monsoon period the substation is subjected to high winds from the sea and to torrential rainfall of up to 20in in twenty-four hours. The transmission system also is in an area subject to lightning storms.

To meet these conditions the transformers are designed for a temperature rise of 40 deg. Cent. (oil) and 55 deg. Cent. (by resistance) and have an impulse voltage level based on 550kV and 95kV, respectively, for the high voltage and low voltage windings with a 1½/40 microseconds full wave.

Connected star-star, the transformers are equipped with a 33⅓ per cent delta tertiary winding. The ends of this winding are brought out for testing purposes to terminals, which are normally protected by polythene insulating covers. The high voltage and both the neutral terminals are porcelain bushings, while the low voltage windings are brought out to dis-

connecting chambers and cable-boxes, equipped to receive five single-core cables per phase.

Cooling is by means of a Serck, horizontal, water-cooled heat exchanger, compactly mounted on one end of the transformer, the oil being circulated through a bank of tubes cooled by water flowing in the surrounding casing. Oil circulation is by means of a glandless pump, also mounted on the transformer tank, immediately above the cooler, and situated in the run of the oil feed to the top of the transformer.

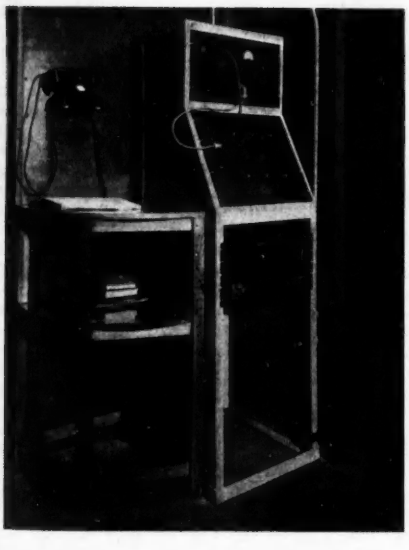
In accordance with the latest Hackbridge practice, the oil-feed from the conservator vessel is piped to the bottom of the transformer tank, with a corresponding departure from the orthodox lay-out of the oil expansion and air release pipework. This arrangement, with its effect of maintaining the oil in the conservator vessel at a lower temperature, reduces oil deterioration in service and is therefore of particular value on units for service under tropical conditions.

The transformer illustrated herewith in the works of the makers, Hackbridge and Hewittic Electric Company, Ltd., is one of two which have been shipped to India. Shipment was effected without oil, the transformers being sealed in dry air under pressure, to reduce weight in transit to site, where they will be filled with oil. The weight of each unit complete with oil is 55 tons.

200kV Schering Bridge

A 200kV Schering bridge for use at power frequencies has recently been installed in the high voltage laboratory at the Witton works of the General Electric Company, Ltd. The instrument, which is intended for the measurement of power factor, capacitance and dielectric losses in insulating materials, was designed and made by Salford Electrical Instruments, Ltd., with a standard gas-filled capacitor supplied by The Bushing Company, Ltd.

The low voltage parts of the bridge have been designed for rack-mounting, as shown in our first illustration, and consist of ratio

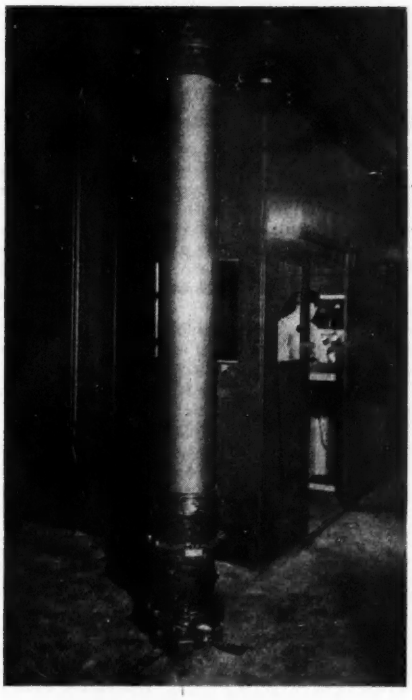


SCHERING BRIDGE CONTROL UNIT

arms, a detector unit and a small power unit for supplying the detector.

Visual observation is made of the null condition on the bridge and the detector unit comprises a three-stage amplifier, thermionic rectifier and milliammeter. The first stage of the amplifier has a feedback filter to attenuate harmonics, whilst a parallel "T" filter in the second and third stages provides a frequency-selective feedback. Variable sensitivity for the bridge is provided by means of a potentiometer interposed between the last amplifier stages.

In this kind of bridge used for precision measurements, the constructional details and, in particular, the disposition of the components, is of considerable importance. Cathode follower networks have been employed between the bridge, test specimen and the standard capacitor to counteract the effects of stray capacitance and the capacitance of connecting cables. The type of decade switch has been chosen with particular care so as to maintain accuracy and consistency of results. Inductive loops



SCHERING BRIDGE CAPACITOR AND CONTROL ROOM

have also been kept to a minimum in the main circuits.

The power supply unit supplies well-smoothed d.c. to the cathode follower networks housed in the ratio arm unit and to the detector unit. Low voltage d.c. is also supplied to the valve filaments in both units. By this means any interference with the detector, due to a.c. pickup and hum, is eliminated. This arrangement also permits the use of separate a.c. supplies for the detector unit and the high voltage part of the bridge.

The high voltage arms of the bridge, comprising the standard capacitor and test object, are arranged in the main laboratory test area remote from the bridge ratio arm and detector units.

Robust spark-gap protective devices are mounted on both standard capacitor and test object. They incorporate low melting point solder inserts, which, in the event of a test object or capacitor failing, operate and provide a solid connection to earth. The high-speed protective gear associated with the power transformer clears the fault. The operator and bridge components are further protected by low-voltage gas-filled arrestors, which are housed in the ratio arm unit.

Our second illustration shows the standard capacitor, which has a value of 98·5 picofarads and can withstand 200kV r.m.s. Its power factor is sensibly zero. The capacitor consists of two concentric polished brass cylinders mounted vertically and housed in a Texolex cylinder. The inner tube is the high-voltage electrode and is supported from a top casting. The outer tube is the low-voltage electrode and is connected to the centre-pin of a socket mounted on the base of the capacitor. Guard rings are used for stress control and are arranged at the termination of the low-voltage electrode. Metallic screens are used to minimise the effects of stray capacitance. These, together with the guard rings, are connected to the metal base of the capacitor. The dielectric is dry nitrogen at a pressure of 200 lb per square inch and the complete unit is mounted on insulated tripod legs and is self-supporting. Its overall height is 8ft.

The bridge permits capacitances between 20 and 20,000 picofarads to be measured with an accuracy of ± 1 per cent or ± 1 picofarad, whichever is the larger. This range is covered in five steps in a geometric progression by means of shunt selection. Power factors between 0·0001 and 0·5 can be determined with an accuracy of ± 10 per cent or ±0·00005 whichever is the larger.

Two New Netherlands–Denmark Telephone Cables

On September 4th, H.M.T.S. "Monarch" completed the laying of two new high-speed submarine telephone cables between Oostmahorn (Holland) and Romo (Denmark). In each cable two submerged repeaters were inserted; the length of each cable was 142 nautical miles.

These cables will greatly improve communication between the Scandinavian countries and Western Europe, and it is anticipated that most of the telephone traffic will be handled over these routes. The cables were made for the Netherlands and Danish Administrations by Submarine Cables, Ltd., at the Greenwich Works of the Telegraph Construction and Maintenance Company, Ltd., and took some fifteen months to manufacture.

The construction consists of a specially designed composite conductor, insulated with Telcothene, to a diameter of 0·935in. Over the core is a copper screen composed of six spirally applied tapes, and these are lapped with a short lay copper tape, the whole forming the "return" conductor. This screen is then served with tarred jute yarn to form a bedding for the armouring wire, which consists of fifteen No. 2 gauge steel wires. Finally there are two [servings of tarred jute yarn, the finished gauge being approximately 2in and having a weight of about 13 tons per nautical mile.

For some distance the landward ends are protected by a further insulation of Telcothene of radial thickness 0·10in. This protection enables any extraneous currents which may be induced in the outer conductor near the shore to be controlled and minimised; as an added precaution against interference a lead sheath is applied to the lengths in trenches.

The electrical characteristics of the cable are as follows, at 15 deg. Cent. per nautical mile.

D.C. Resistance (Central conductor) ...	1·13 ohm.
Capacitance	0·185 microfarad
D.C. Insulation	5×10^6 megohm
Attenuation at 352 kc/s	1·55 db/n.m.

The total length of each cable is 142 nautical miles, divided as follows: northern section, 62; central section, 40; southern section, 40.

Each cable provides thirty-six telephone circuits, "go" and "return." In the Netherlands-Denmark direction the frequency band 24 to 168 is used and in the Denmark-Netherlands direction the frequency band is 208 to 352 kc/s. The total cable attenuation at 352 kc/s is 220 db. This value is being divided into 96, 62, 62 for the three sections, respectively.

The gap between the frequency bands is used for supervisory and signalling circuits. In the low frequency band below 24 kc/s an audio frequency non-repeatered speaker circuit is provided. The power to operate the submerged repeater is obtained from the terminal apparatus at the shore ends of the cable and is fed over the central conductor.

Apart from the shore ends, which had been previously laid by two small craft belonging to the Administrations, the main cable of 240 nautical miles was laid by H.M.T.S. "Monarch," the weight of the cable being over 3000 tons.

American Engineering News

(By our own Correspondent)

Evaporation from Water Reservoirs

Research into a comparatively little-known, but important, phase of water resources development—evaporation from reservoirs—is now being undertaken by the U.S. Department of the Interior in co-operation with several other governmental agencies. Studies have been started on Lake Hefner, near Oklahoma City, which are expected to provide more exact data concerning the amount of water lost by reservoirs through evaporation to the atmosphere. The scientific investigations are proceeding under the direction of the U.S. Geological Survey with the assistance of the U.S. Navy and Weather Bureau. The Oklahoma City studies will make use of the energy budget and the mass-transfer theory methods of determining evaporation, using the well-known water budget method as a check. Lake Hefner is an almost perfect "saucer," approximately 2½ miles in diameter, scooped out at the very headwaters of a drainage basin. Through a dike almost 4 miles long very little water is lost, and even this can be measured accurately. The lake bottom is of compacted red clay and is nearly impervious to water leakage. Last winter, engineers of the Bureau of Reclamation calibrated the venturi meter at the filtration works which measures the amount of water drawn from the lake to supply Oklahoma City. This meter is now considered accurate to within 1 per cent. Rain gauges have been set up at twenty-three points on and around the lake to measure the amount of rainfall. Multiplying this figure by the total lake surface will give the amount of water added directly through precipitation. As a further check on the drainage basin, weirs and recording gauges have been installed near the mouths of the two inlet streams. As there are almost no trees on the reservoir rim, losses by transpiration may be disregarded. To underline the importance of the study, it is stated that the annual evaporation loss from Lake Mead, which was created when Hoover Dam was constructed, has been estimated at more than 800,000 acre-feet, equivalent to about 25 trillion gallons. The total losses from present and proposed reservoirs in the Colorado River basin, together with channel losses in the lower part of the basin, are likely to exceed 2,000,000 acre-feet per annum. At present it may not be practical to devise means of preventing evaporation from reservoirs, but more knowledge regarding rates of evaporation may determine the location and capacity of proposed reclamation structures and would be of value also in setting up operating schedules to provide optimum utilisation of water.

Remote-Control Pipe-Line Operation

An interesting and original "tele-type" remote-control system is now being used to control the flow of petroleum products through a 450 mile long pipe-line of the Shell Oil Company. The pipe-line begins at the company's Wood River refinery in Illinois and runs through four pumping stations in Illinois and Indiana to two terminal points in Ohio. The line is equipped to carry up to twenty-two different petroleum products. Pumps and valves in the four pumping stations are all controlled by a dial-equipped tele-type machine at the headquarters of the company in New York City. Assume that it is required to send a batch of naphtha from the refinery to a distribution point at the first pumping station along the pipe-line, and that the stretch of pipe concerned is already loaded with another product. Hence, in New York, a dispatcher traces the location of the products on a control board which simulates the actual pipe-line. When this board shows that the product already in the line has reached the required amount, the dispatcher turns it off and turns on the naphtha —both by dialling the appropriate code signals on the tele-type machine. As the naphtha enters the refinery end of the line, it mixes slightly with the preceding product, but the resulting contamination is not sufficient to spoil the quality of either product as the line pressure and product viscosities are carefully regulated. When the board shows that the naphtha has reached the first pumping station the dispatcher dials another code signal in order to switch the naphtha off the main line and into storage tanks at the distribution centre. One such code signal, in this particular case, starts a lubricating pump, opens an upstream valve, starts the main pump, opens the discharge valve and opens a valve which brings the pumping station back on to the main line. As soon as any product commences its travel along the line, discharge pressures, suctions and power consumption are automatically recorded at the New York headquarters by means of a telemetering system. Each pumping station is manned by one operator for stand-by and maintenance purposes. Should manual operation of a station be required, the operator is summoned by a siren controlled in New York.

Central Railroad Research Laboratory

The new Central Railroad Research Laboratory of the Association of American Railroads was formally opened in Chicago recently. Apart from the main building containing a number of well-equipped laboratories, it has an inclined test track adjacent to the building and to the New York Central—Rock Island main line tracks. The work of the laboratory is conducted within the divisions of general engineering, mechanical engineering, refrigeration, containers and sanitation, and a large number of projects currently being undertaken are for the construction and maintenance section of the Association of American Railroads. The current work of the general engineering division includes rail design studies, rail anchorage tests, the development of a brine corrosion inhibitor and a study of impacts and bridge stresses. Among the projects of the mechanical division, there are studies of alloy steel axles, roller bearing lubricants, wagon side frames and bolsters, metal running boards and other appliances, frequently with a view towards a revision of current A.A.R. specifications. One of the most important projects being undertaken by the refrigeration division is a detailed study of the possible application of pallets and power lift trucks to refrigerator car loading. This project involves the consideration of a change in door design to facilitate the entry of fork-lift trucks, and a change in floor specifications in order to accommodate the additional weight.

Electrolytic Tinplate

A new electrolytic tinplating line, claimed to be the largest and fastest line in the world, commenced operations recently at the Weirton Steel Company, Weirton, West Virginia. The line has a speed range of 2000ft to 2500ft per minute and its annual capacity is rated at 5,000,000 base boxes, each box equivalent to 112 sheets of plate, 14in by 20in. The line incorporates electrical equipment having a total capacity of 12,000kW. Use is made of high-frequency induction heating for the reflow brightening of the tin coating. It is of interest to note that one such electrolytic line has an output equivalent to that obtainable from twenty-five automatic-feed, hot dip tinning lines.

Progress of T.V.A.

A report issued by the Chairman of the Tennessee Valley Authority states that the service area of the large multiple-river resource system is stronger and better prepared to-day for wartime emergencies than it was at the advent of the last war. The current three-year expansion programme will increase T.V.A. power production from 17,000,000,000kWh to 25,000,000,000kWh a year by January, 1954, at an estimated cost of 250,000,000 dollars. This includes 400,000kW capacity from the Cumberland River dam projects, which are being constructed by the U.S. Army Corps of Engineers, but which will deliver power to T.V.A. Of the eventual output, 330,000kW will be transmitted to the Oak Ridge atomic energy establishment for use in the supplemental atomic energy project recently authorised by President Truman.

The principal project within the expansion programme is a new steam power station at Jacksonville, Tennessee. It will have six generator units with a total capacity of 750,000kW and will cost 89,000,000 dollars. The first generator is scheduled to be installed in October, 1951, and the station is to be completed altogether by the autumn of 1953. The second major project is a steam power station at Widow's Creek, near Stevenson, Alabama. It will have two generator units with a capacity of 250,000kW, will cost 34,000,000 dollars, and is scheduled to be completed by the end of 1952. Finally, the expansion programme includes the construction of several new dams and the installation of seven new generator units in vacant stalls at existing dams.

An Aerial Navigational Device

The "Omnirange" navigational device, designed to aid military, commercial and private flying, is in operation now 8 miles west of Caldwell Airport, New Jersey. It is one of several which will eventually serve the New York metropolitan area. The apparatus transmits beams in all directions, compared with the widely used radio ranges, which generally have only four or five "legs." With the appropriate equipment installed in his aircraft a pilot simply tunes a wireless set to the frequency of the "Omnirange" and is then able to fly directly to it by following a needle on the instrument panel. Unlike using an automatic direction finder, no correction for wind drift is necessary and magnetic variation is corrected by the "Omnirange" itself. All its courses are in terms of the local magnetic field. The Caldwell "Omnirange" is monitored constantly by personnel of the Civil Aeronautics Administration at La Guardia Airport, who check its transmission by reception over telephone wires. Should its main transmitter fail, an auxiliary one commences operation automatically. Similarly, if the normal supply of electric power should fail, a petrol-powered generator goes into operation immediately. One of the major advantages of the new device is claimed to be its complete freedom from static, on account of its use of very high-frequency transmission. The next "Omnirange" to go into operation will be at Westchester County Airport, New York. In general, in the East, swamps and level sites will be chosen as sites; in the West preference will be for mountain tops. The installations are manned by a team of two technicians each.

Safety Code for Mechanical Refrigeration

The American Standards Association has announced the complete revision of the American Standard Safety Code for Mechanical Refrigeration as a result of investigations of the safety of refrigeration equipment, covering both its design and installation. The newly revised code is expected to serve as a recognised authority for minimum safety and to be uniformly acceptable to enforcement authorities. In general, it has been considerably simplified and is more comprehensive than the 1939 code. The major change results from co-operation with the American Society of Mechanical Engineers in bringing about an agreement with the A.S.M.E. Code for Unfired Pressure Vessels and a meeting of the requirements of the Underwriters' Laboratories. The code has also been liberalised to some extent with regard to the use of the safest of the three classes of refrigerants and the installation of tubing in places where it had formerly been forbidden.

Ships for Military Transport

A total of 123 vessels have now been withdrawn from the National Defense Reserve Fleet sites on the Atlantic, Pacific and Gulf Coasts. Of these, twelve have been troop transports, one a "C-4" cargo vessel and the remainder "Victory" cargo vessels. The troopships are being refurbished and will be operated by the U.S. Navy, but the majority of the other vessels are being handled in private shipyards for operation by commercial steamship companies under Military Sea Transport Service assignments. Five of the "Victory" and the "C-4" vessels are being placed under the custody of the service for use in connection with special military operations.

Industrial and Labour Notes

The National Coal Board

During the past week or so the National Coal Board has published a statistical statement on production costs, proceeds and profit or loss of collieries for the second quarter of 1950. It records that during that period the Board made a profit—before charging interest—of £6,728,971, compared with £9,953,011 in the first quarter. The profits of ancillary undertakings in the second quarter have been estimated at £470,000. From the trading profit, provision has to be made for compensation for loss of office, interest payable to the Minister of Fuel and Power, and also an estimated liability for profits tax, with the result that the Board's surplus at the end of the second quarter is given as £2,451,971, compared with £5,600,011 in the first quarter.

During the second quarter the statement shows the saleable tonnage of coal was 50,083,774 tons, of which 46,337,819 tons were disposable commercially. Production costs are given as £113,431,442, the principal item being wages (including holiday pay and allowances in kind), which accounted for £73,601,229. Expenditure on roof supports, general stores and repairs was £17,080,202, the coal and power consumed cost £6,365,875, and other costs, including depreciation, amounted to £16,384,136. Average earnings in the second quarter were, for all workers, £8 19s. a week, and, for underground workers, £9 10s. 11d. a week, both figures including the value of allowances in kind.

The National Coal Board has pointed out that, in considering the second quarter's results, it should be borne in mind that the period included the Easter and Whitsun holidays.

Coal Supplies

On the motion for the adjournment of the House of Commons last Monday evening, Mr. Harold Davies raised the subject of Britain's coal supplies, in view of its importance in relation to the defence programme. The Parliamentary Secretary to the Ministry of Fuel and Power, Mr. Robens, replied to various points raised in the debate, and emphasised that the country must have 16,500,000 tons of coal in stock before the onset of winter. That, he said, was not necessarily tied to a given date, such as the end of October, because weather played a part in it; but generally stocks began to be lifted towards the end of the year and there was not, therefore, much of a breathing space beyond the end of October to get the 16,500,000 tons in distributed stocks.

On September 9th, Mr. Robens continued, total distributed coal stocks amounted to 13,400,000 tons, which did indicate an improvement. At the same time the gap between 13,400,000 tons and 16,500,000 tons—which was absolutely essential as a minimum—was far too wide. Inland coal consumption, Mr. Robens observed, had continued to increase during 1950, and in the thirty-five weeks to September 2nd had amounted to 133,200,000 tons. In the corresponding period of last year it was 129,500,000 tons, so, in thirty-five weeks, there had been an increase over last year of 3,700,000 tons. That, Mr Robens said, presented a great difficulty, because during the same period of thirty-five weeks production had only increased by 1,800,000 tons. In other words, we were losing ground to the tune of nearly 2,000,000 tons of coal already this year. Mr. Robens went on to say that this country could not tolerate an approach to a fuel crisis such as it had a few years ago and "reasonable temperatures for winter" could not be reckoned upon. That was why it was so essential that stocks should be at the level he had indicated. He added that it had been agreed to get industrial coal stocks up to a level of about four and a half weeks, which was a good safety margin, by about the middle of December. In that connection, industrialists would require during those weeks to take what coal was offered to them. He did not think it was any use at all industrialists refusing to take coal which might have to come from a coalfield other than their usual source of supply.

Iron and Steel Production

The British Iron and Steel Federation has now issued figures concerning the iron and steel industry's output in the month of August. During that month the production of steel ingots and castings averaged 279,400 tons a week, which indicates that output was at an annual rate of 14,530,000 tons. Steel production in August this year was therefore affected by holidays to a greater extent than last year. In August, 1949, output was at an annual rate of 14,953,000 tons. Last month's production of pig iron averaged 177,000 tons a week, which represents an annual output rate of 9,205,000 tons.

In its statement, the Federation points out that Bank Holiday this year fell on August 7th, whereas last year it was on August 1st, and in certain districts, therefore, holidays were about a week later than last year. But, taking the first eight completed months of 1950, an annual rate of steel production of 16,063,000 tons has been achieved. It will be recalled that the target set for this year was from 15,750,000 tons to 16,000,000 tons.

Railway Wage Claims

It will be recalled that, during July, the three railway unions announced their intention to submit claims for wage increases. The claim advanced by the Railway Clerks' Association was for an all-round increase of 7½ per cent on existing salaries, that formulated by the Associated Society of Locomotive Engineers and Firemen was for a wage increase of not less than 15 per cent for all its members, and the National Union of Railwaymen pressed for a 10 per cent increase.

At the end of last week, it was stated that the Railway Executive had rejected all the claims on the ground of its inability to make any new offer in view of the financial position of the railways. The N.U.R. executive considered the rejection on Friday last and decided to refer the matter to its negotiating committee. A point at present being emphasised by the N.U.R. is that existing wage-rates are not sufficient to enable the railways to keep staff or to encourage recruitment to railway service.

Employment and Unemployment

In its latest report on the employment situation in Great Britain, the Ministry of Labour says that during July the total working population increased by 9000 and at the end of that month numbered 23,334,000 (16,062,000 men and 7,272,000 women). The total number of people in civil employment at the end of July was 22,359,000 (15,190,000 men and 7,169,000 women), an increase of 5000 during the month.

The report shows that there was no change during July in the number employed in the country's basic industries, an increase in the number of people engaged in gas, electricity and water undertakings being offset by a further decrease in the coal-mining industry. At the end of July the number of wage-earners on colliery books was 697,000, which indicates a drop of 12,000 since the end of last year. In the manufacturing industries 8,402,000 people were employed at the end of July, or 6000 fewer than at the end of June. The "metals, engineering and vehicles" group was one employing less people in July, its total at the end of the month being 3,926,000, compared with 3,929,000 at the end of June.

The Ministry's latest figures for unemployment show the position on August 14th, when 288,311 people were registered as out of work, compared with 271,975 on July 10th. The August figure, it is stated, represented about 1·4 per cent of the total number of employees insured under the national insurance schemes.

British Overseas Trade

At the end of last week the Board of Trade issued provisional figures relating to the United Kingdom's export and import trade during August. These figures show that exports last month reached a new record at £189,300,000, a figure which was £19,900,000 above the monthly average for the second quarter of this year. There were twenty-six working days in August and the rate of exports was 7 per cent higher than the monthly average of the first half of the year. August imports have been valued provisionally at £214,900,000 and re-exports at the high figure of £7,400,000, so that the excess of imports (valued c.i.f.) over total exports (valued f.o.b.) was £18,100,000, the lowest figure since February, 1949.

Exports during August to the U.S.A., valued at £11,000,000, were nearly as high as in July and were 51 per cent above the average for the second quarter of the year. The provisional value of exports to Canada in August has been given as £12,200,000, a figure 19 per cent higher than the average for the second quarter, but slightly below the record total for May. The combined figure for exports to North America in August was thus equivalent to 64,800,000 dollars and, the Board of Trade says, was 29 per cent more than the record quarterly average achieved in the fourth quarter of 1948.

Industrial Disputes

Answering a question in Parliament on Tuesday last, the Minister of Labour, Mr. Isaacs, said that the number of stoppages of work arising from industrial disputes, reported as beginning in the twelve months ended August 30th, was 1334. The majority of them, however, were stoppages of brief duration involving only small numbers of men. The Minister went on to say that the question whether those stoppages were in contravention of the Conditions of Employment and National Arbitration Order could only be authoritatively determined in the courts, and he had not thought it appropriate to institute proceedings in respect of any of the stoppages. But he had no intention at present of revoking the Conditions of Employment and National Arbitration Order, which, he felt, continued to serve a useful purpose.

The Price of Copper

The Minister of Supply, Mr. Strauss, was questioned in the House of Commons on Monday last about the recent fluctuations in the price of copper. He acknowledged that the recent rapid fluctuations in price were very inconvenient, but pointed out that industry had expressed itself satisfied with the policy of keeping our price in conformity with the American price.

The Minister was also asked what proposals he had to compensate exporters of heavy electrical equipment, who needed to cover their requirements many months ahead, for having to pay the premium on their forward purchases of copper. His reply was that the premium was imposed to protect the Exchequer from the results of heavy forward buying at a time of great uncertainty about future buying prices. The matter was under discussion with industry to see whether an alternative method could be found which would be more acceptable to the trade while providing the necessary protection to the Exchequer.

French Engineering News

(From our French Correspondent)

American credits are being used to assist soil conservation works in Algeria. The Algerian Government proposes to protect about 50,000 hectares of land from soil erosion per year. About fifty heavy tractors are already in use and about sixty others, ranging from 45 h.p. to 140 h.p., are to be supplied, in addition to other muck-shifting plant. This work will be carried out in conjunction with irrigation projects.

* * *

In the Nord and Pas-de-Calais coal-mines mechanisation is being advanced by the use of the plane, the scraper-plane and the mechanical coal-cutter. The first system attacks the vein in the same way as the carpenter's plane. The cutter, drawn by two cables, with high-powered winches, removes 30 cm sections, the coal falling into an armoured conveyor, which removes it. The scraper-plane is a lighter machine for use in less important sections. It is a kind of open box, which is moved to and fro by cables, cuts the coal and carries it off. In the hard veins, the coal-cutter, which works like a saw, is still best. A mobile arm, fitted with picks mounted on an endless chain, attacks the vein. In addition to this equipment, jumbos and duckbills from America are also being used. As modern cutting methods are introduced so metal props are replacing wood.

The Loire mines have started sinking a new pit about 50m from the old Verpilleux pit, which was not sufficiently deep and of too small diameter to serve the seam. The new pit will be one of the more modern in the basin, going down to 630m with a 6m 20 diameter. Extraction capacity will be about 2000 tons for each of two machines. Installations are completed by a new washing-sorting plant. By the time Marshall Aid comes to an end the Loire basin will have four modern pits, a central sixty-oven coking plant and a 100,000kW electricity generating plant, using inferior quality fuel.

* * *

The shipyards of the Loire at Saint Nazaire have been enlarged and re-equipped. A new, 145m long building, housing social services and plant, has been completed. Construction of a factory for small mechanical parts has also been started. The old, 150-ton fixed crane is being replaced by two mobile cranes, which can cover the length of the quay. The first will have an 80-ton hook and 21m radius, and a 20-ton hook and 50m radius. The second will have an 8-ton hook and 21m radius and a 5-ton hook with 54m radius.

* * *

Potassium seams in the Landes Departement are being exploited by the Ste. Minière du Sud-Ouest, assisted by the Mines Domaniale de Potasse d'Alsace. A pit has been sunk to a depth of 725m, and six levels are being exploited, served by over 10km of galleries. Content of pure potassium is between 14 and 19 per cent. The pits have been equipped for a regular daily extraction of 600 tons and for the period May, 1950, to May, 1951, 80,000 tons will be produced and delivered in a crude state for agricultural use, while awaiting the construction of concentration factories. Work is also proceeding to enable the layers of magnesium salts below the potassium to be recovered.

* * *

Decreased steel production in July, due to paid holidays, coincided with increased demand from abroad, resulting in a general steel scarcity, which is not, however, expected to last. Exports for July amounted to 54 per cent of production compared with 42 per cent in June and 36 per cent in May. The quantity available for the French market has therefore diminished. Negotiations are taking place for the delivery, to the U.S., of 150,000 tons of steel products, which is four times the average for the first months of this year. American industry has already applied to French firms for the manufacture of high-quality ferro-manganese, in which two French companies specialise.

Notes and Memoranda

Air and Water

H.M.S. "BRECONSHIRE."—Sunk in 1942, this former merchant ship, originally owned by the Glen Line, Ltd., has been successfully raised from her resting place at Marsa Xlok, a bay in Malta, where she has prevented the full use of the anchorage. Now floating bottom up, the vessel is on her way to Genoa to be broken up.

LLOYD'S REGISTER WRECK RETURNS.—Lloyd's Register of Shipping wreck returns for the quarter ended December 31, 1949, show that sixty-six ships, totalling 57,580 gross tons, were lost due to casualty or stress of weather, including sixty-three steamers and motorships, amounting to 56,220 gross tons, of which six ships, representing 16,137 gross tons, belonged to Great Britain and Northern Ireland. The ships broken up through causes other than casualty or stress of weather totalled 109,261 gross tons, representing forty-three ships, forty-one of which were steamers and motorships of 38,672 gross tons, and of these twenty-five ships, having a total of 68,073 gross tons, were owned in Great Britain and Ireland. The gross reduction in the Mercantile Marine of the world from all causes during the quarter was therefore 109 ships, representing 166,841 gross tons.

STUDENTS' TOUR OF BRITISH SHIPYARDS.—The British Council has arranged a two weeks' tour of British shipbuilding centres for a party of twelve third-year students of naval architecture from the Trondheim Technical University. Under the leadership of Professor Georg Vedeler, who recently supervised the construction of a number of ships for Norway in Britain, they spent four days in the Netherlands before coming on to Britain on September 18th. Their tour of shipyards began in Glasgow with visits to Greenock, Dumbarton, and Cambuslang. On Sunday next they go on to Newcastle where they will be joined by a party of three lecturers and seventeen students from the Technical University at Delft. During next week the Dutch and Norwegian students will visit shipyards and engineering works in Newcastle, Middlesbrough, Sunderland and North Shields.

Miscellanea

EXPORT OF WROUGHT COPPER.—Under an Order made by the Board of Trade, export licences are now required for shipment of wrought copper and alloys "mainly of copper" in certain forms to any destination.

HIGH-TEMPERATURE ALUMINIUM PAINT.—We are informed by Solignum, Ltd., the makers of "Norusto" aluminium preservative paint, that it has now produced an aluminium paint for furnace applications which will stand temperatures up to 1500 deg. Fah. This paint, which can be applied by brushing or spraying in the ordinary way, is stated to attain its best weather-resisting properties and brilliance at temperatures of 800 deg. Fah. and over.

GOVERNMENT FACTORY AT CLAYTON-LE-MOORS.—The Board of Trade announces that it has allocated the surplus Government factory at Clayton-Le-Moors, Accrington, to the English Electric Company, Ltd., for light engineering and the manufacture of electrical equipment. The factory is at present occupied by Courtaulds, Ltd., which firm, owing to reorganisation, is giving it up. It is the intention of the English Electric Company, Ltd., to absorb the existing labour force.

STEEL CASTINGS RESEARCH.—It has been announced recently that a basis of collaboration has been established between the technical and research division of the Steel Founders' Society of America and the research and development division of the British Steel Founders' Association. The intention is that these two research organisations shall exchange information relating to their research programmes and upon certain specified fields of research, both fundamental and applied.

FACTORY CANTEENS.—A useful little book on the lay-out and organisation of factory canteens has just been published by Emmott and Co., Ltd., 31, King Street West, Manchester, 3, at 2s. 6d. net. This book, after dealing with the need for a canteen and social centre at a works, describes in some detail how to estimate the size of a canteen and plan its lay-out. Other sections deal with kitchen lay-out and equipment and food preparation rooms and services. The author, Mr. H. M. Harman, has obviously made a very close study of his subject and he provides in this book much useful guidance and information for industrial establishments contemplating the introduction or reorganisation of canteen facilities.

POWER STATION CONSENTS.—The British Electricity Authority has received the consent of the Ministry of Fuel and Power to the development of the new Staythorpe power station to its full capacity and to an extension of the Huddersfield power station. The authorisation covers the installation at Staythorpe of a 60MW turbo-alternator and four boilers, each of an evaporative capacity of 240,000 lb per hour. When fully completed, this station will have a total installed capacity of 360MW. The Huddersfield consent covers the installation of a 30MW set and two boilers, each of an evaporative capacity of 180,000 lb per hour, as well as the construction of a cooling tower.

LECTURES ON REFRACTORIES.—During the coming winter session of the Northampton Polytechnic, St. John Street, London, E.C.1, a course of lectures on "Refractories, Their Manufacture, Properties and Uses," will be delivered by Mr. L. R. Barrett. The lectures will be given on Tuesday evenings at 7 p.m., commencing on October 3rd. The course has been organised primarily to provide a detailed and up-to-date survey of refractories and the refractories industry for technologists engaged in the metallurgical, fuels, carbonising, glass and chemical industries. It will, however, be suitable for students of metallurgy and of other related branches of applied chemistry, provided they possess the necessary fundamental knowledge of chemistry.

SCIENCE MUSEUM EXHIBITS FOR THE BLIND.—A display of exhibits and models specially arranged for the blind and the partially sighted is to be held at the Science Museum. An experimental display for the blind held in June, 1949, proved very popular, and as a result of this success a further and more ambitious exhibition will be staged from Saturday, November 11, to Sunday, December 10, 1950. The display will not be open to the general public and will be staged in Gallery 1—to the right of the main entrance, Exhibition Road—thus avoiding the use of the staircase or lift. The exhibits and models will be arranged on tables together with a shortened version in Braille of the standard printed label, a copy of which will also be supplied so that escorts may read the fuller information to the blind, when desired.

A NON-FERROUS METALS HANDBOOK.—The tenth edition of the "Non-Ferrous Metals Handbook" of Charles Clifford and Son, Ltd., Dogpool Mills, Birmingham, 30, has just been issued by the company. This edition of the book has been revised and enlarged and now contains some forty pages of useful information. It gives many comprehensive tables of weights relative to non-ferrous metals, in sheet, strip, rods and bars, wire and drawn strip, tubes and chill-cast bars, together with tables of gauges, English metric conversion tables, a useful ready reckoner, and many pages of general information in respect of non-ferrous metals. Buyers and trade users of non-ferrous metals will find this comprehensive handbook a very useful addition to their works of reference. It can be obtained free of charge upon application to the company.

Contracts

VICKERS-ARMSTRONGS, Ltd., announce that they are to build a self-unloading ore carrier of 15,000 tons gross for Reynolds Jamaica Mines, Ltd., to transport bauxite from Jamaica to the United States.

A CONTRACT has recently been signed with the Saudi Arabian Government for the construction of a main road between Jedda, the principal port in Saudi Arabia, and Medina, one of the sacred cities of Arabia, about 260 miles north-west of Mecca. Together with bridges and ancillary works, the contract is expected to total over £3,000,000. The contractors are Braithwaite and Co., Engineers, Ltd., working in collaboration with Thos. W. Ward, Ltd.

THE GENERAL ELECTRIC COMPANY, Ltd., has received orders from the British Electricity Authority for three 60MW, 11·8kV, 3000 r.p.m., hydrogen-cooled turbo-alternators. Two of the sets are for a new power station to be erected at Ince, near Capenhurst, in the Wirral Peninsula, for the Merseyside and North Wales Division, while the third set is for a further power station which will be built at Hams Hall to be known as Hams Hall "C." The equipment will be designed and built at the G.E.C. engineering works at Witton and Erith, where six further 60MW hydrogen-cooled sets are at present under construction for the Uskmouth power station, near Newport, Mon.

British Patent Specifications

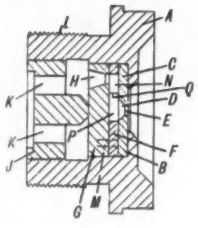
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

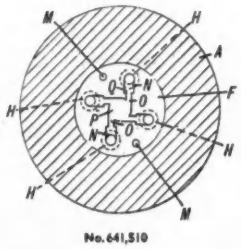
Copies of specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

INTERNAL COMBUSTION ENGINES

641,510. February 16, 1948.—Improvements relating to Liquid Fuel Injection Nozzles, Joseph Lucas, Ltd., a British Company, of Great King Street, in the City of Birmingham, 19 (*Inventor, Ralph Barrington*).

This invention relates to liquid fuel injection nozzles of the kind in which the liquid is supplied to a swirl chamber adjacent to a discharge orifice by one or more passages adapted to direct the liquid from a supply passage tangentially into the outer peripheral region of the swirl chamber. Referring to the drawings, a hollow body part *A* has at its front end a shoulder *B* against the rear side of which is placed a plate *C* which at its centre has formed in it a conical swirl chamber *D* leading to a discharge orifice *E*. At the back of the plate *C* is placed a plate *F* having formed therein tangential passages. Behind this plate is placed a fluid inlet plate *G* having therein several ports *H* through which fluid can flow from the interior of the





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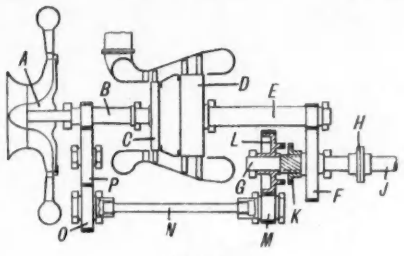
body part. The various components are held in position by a plug *J* formed with passages *K* and screwed into the rear end of the body part, secured to a supply pipe by the screw thread *L*. For locating the plates *F* and *G* in proper mutual relationship, dowels *M* engage holes in both plates. The essential feature of the invention resides in the passages formed in the plate *F*. Looking at the lower section it will be seen that the end *N* of each of the passages which is adjacent to a port *H* in the plate *G*, is made to a width corresponding to the diameter of the discharge end of the port. The part *N* of each passage opens into a narrower part *O*, which is tangential to a central hole *P* in the plate *F*, the diameter of the hole corresponding with the adjacent end of the swirl chamber in the plate *C*. The parts *N*, *O* are made of any convenient relative length, and at their junction they are formed with an abrupt shoulder *Q*. By so shaping the passages in the plate *F* strongly active turbulence is set up in the liquid flowing therein with the result that the undesired effect of viscosity in the flow in the swirl chamber is greatly reduced or eliminated.—*August* 16, 1950.

GAS TURBINES

641,377. December 12, 1947.—Improvements in and relating to Combustion Turbines, The Minister of Supply, of Adelphi, Strand, London, W.C.2, and Andrew Thompson Bowden, of 14, Wellburn Park, Jesmond, Newcastle-upon-Tyne, and C. A. Parsons and Co., Ltd., of Heaton Works, Newcastle-upon-Tyne, 6 (*Inventors, Andrew Thompson Bowden, Alfred Müller, Paul Kolb, Waldemar Hryniszak, and Otto Zadnik*).

The main object of the invention is to provide a method and means for obtaining braking power when none normally exists, or for increasing it when it does exist. In carrying the invention into effect in the form illustrated, a compressor *A* is coupled through a shaft *B* to a compressor turbine *C*, whose output is used solely for driving the compressor. The working gas, after passing through the compressor turbine *C*, is led through, and gives up a further proportion of its energy to, an output turbine *D*, which is coupled through a shaft *E* and gearing *F* to an output shaft *G*, on which is fitted a clutch *H* and a final output shaft *J*. This is the normal method of operation of the unit. If the load on the shaft *J* be reduced, or if the clutch *H* be released, the output turbine *D* tends to accelerate. When the speed of the output turbine becomes greater than a certain proportion of the speed of



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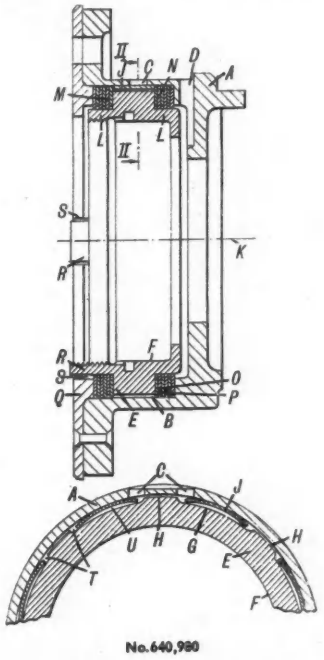
the compressor set *A*, *C*, a coupling *K* and *L* is effected. This coupling has one half *K* fixed to the output shaft *G* and the gear *F*, while the other half is mounted concentrically with the first half *K*, but is free to move in such a way that it normally runs independently of the first part *K* and, therefore, of the output shaft *G*. The part *L* of the coupling is mechanically connected to the shaft of the compressor set through a gear *M*, quill shaft *N* and further gears *O* and *P*. The coupling can be of any standard type such that the two halves are brought together and form a solid whole, when the speed of the part *K* tends to become greater than the speed of the other part *L*. The operation of the unit is as follows:—For normal load conditions the coupling *K*, *L* is not engaged and the various shaft speeds may, for example, be N revolutions per minute for the output turbine shaft *C*, 2/5ths N revolutions per minute for the load shaft *G*, 8/5ths N revolutions per minute for the compressor turbine shaft *O*, and $\frac{N}{2}$ revolutions per minute for the quill shaft, the gears being suitably chosen to give these figures. With such an arrangement, should the load requirements be such that the speed of the load shaft substantially falls, no effect is made on the coupling. If, however, the load requirements on the output shaft *G* change so that the speed of this shaft tends to exceed 2/5ths N revolutions per minute, the coupling *K*, *L* will be engaged and the compressor will act as a brake, thereby limiting the speed of the load shaft *G* and of the work turbine *E* to 2/5ths N and N respectively. When the load shaft speed falls below 2/5ths N, the freewheel disengages and the work turbine *D* once more runs separately from the compressor turbine unit.—*August* 9, 1950.

640,980. July 28, 1948.—Improvements in or relating to Bearing Mountings, D. Napier and Son, Ltd., of 211, Acton Vale, London, W.3 (*Inventors, Benjamin William Barlow and Edward Alec Simonis.*)

This invention relates to mountings for bearings and has for its object to provide a mounting for a bearing, particularly for supporting high-speed rotary units, such as the rotors of gas turbines and the like, which will tend to absorb vibration due to slight out-of-balance of the rotors or other causes, and to be to a limited extent self-centering. In the accompanying drawings the upper view is a sectional elevation of the bearing mounting and the lower view is a cross section taken on the Line *II—II*. The mounting comprises an outer sleeve *A* intended for rigid mounting in the casing of the turbo-blower. The outer sleeve is formed with a cylindrical inner surface *B* and has passages *C* and *D* in its circumference for supplying oil to its interior. Disposed within the outer sleeve *A* and substantially concentrically therewith is an inner sleeve *E*, which is internally cylindrical at *F* for receiving the outer race of the ball or roller journal bearing which the mounting is to support. As shown in the lower view, the outer surface of the inner sleeve *E* is formed as a series of relatively wide longitudinal grooves *G* separated from one another by relatively narrow longitudinal ribs *H*. Disposed in each of the longitudinal grooves *G* is a resilient rectangular metal strip *J*, each of such curved form in cross sections in planes normal to the axis *K* of the inner sleeve that it engages the inner sleeve along lines at or near to its sides and the outer sleeve along a line at or near to the centre of its width. At each end of the inner sleeve *E* are cylindrical portions *L* of a radius somewhat smaller than that of the bases of the grooves *G*, thus providing annular spaces between the end portions of the inner and outer sleeves, with which spaces the grooves communicate. Each end seal *M* or *N* comprises a flat ring *O* making a close sealing fit with the inner circumference *B* of the outer sleeve and engaging the adjacent ends of the ribs *H*, but having a radial clearance from the outer circumference of the end cylindrical portion *L* of the inner sleeve, and a small axial clearance from the adjacent ends of the strips *J* of the order of a few thousandths of an inch. Arranged in close contact with this flat ring *O* is a second flat ring *P*, which makes a close fit with the end cylindrical portion *L* of the inner sleeve, but which is spaced from the inner circumference *B* of the outer sleeve by a radial clearance. Next to this second ring *P* is a third flat ring similar to the first flat ring *O*, and next to the third flat ring is a fourth flat ring similar to the second flat ring *P*. A fifth and sixth ring are arranged in a similar manner, the thickness of the sixth ring being selected to give a suitable degree of freedom for radial movement to the inner sleeve *E* when the



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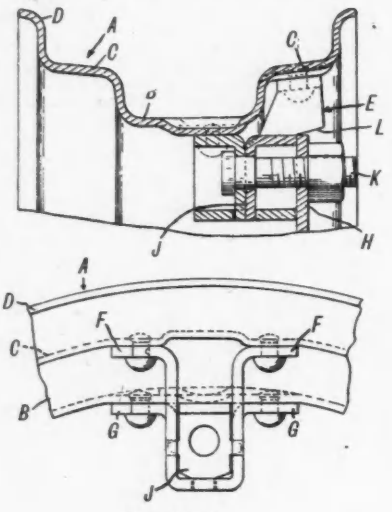
parts are assembled. The inner sleeve and the end seals are held in place in the axial direction within the outer sleeve by an end plate *Q*, which is riveted to an outwardly extending flange on the outer sleeve. One or more dogs or projections *R* are formed on the inner sleeve *E*, which are a free fit in slots *S* in the end plate to prevent significant relative rotation of the inner and outer sleeves. The chambers and clearances in the mounting are filled with oil on assembly, and additional oil can enter through the passages *C* to replace any oil which may leak away in service through the end seals. The bearing is lubricated by oil entering through the passage *D*. Should the axis of the shaft supported by the bearing tend to move rapidly in an orbit the resilient strips *J* will be slightly flattened in succession, thus successively reducing and increasing the volumes of the chambers *T* and *U*. Oil can only flow into or out of these chambers either under the sides of the resilient strips *J* or between the ends of the strips and the end seals, and there is therefore considerable resistance to such changes in volume, which tends to damp out such orbital movements of the shaft. On the other hand, should the shaft tend to rotate about a stationary axis which is slightly eccentric with respect to the outer sleeve, the mounting will permit this eccentricity to an extent which is limited by the contact of a rib *H* with the inner cylindrical surface *B* of the outer sleeve. Should the temperature of the casing supporting the outer sleeve *A* and/or the outer sleeve itself become substantially different from the temperature of the rotating shaft, the mounting will allow for differential expansions or contractions between these parts without the clearances of the bearing itself being appreciably affected.—*August* 2, 1950.

ROAD TRANSPORT

640,409. February 25, 1948.—Rim Attaching Means for Vehicle Wheels, The Kelsey-Hayes Wheel Company, of 3600 Military Avenue, Detroit, Michigan, U.S.A.

The invention relates to means for attaching tyre holding rims to wheel bodies and of that

type permitting of attachment in different offset positions. The object of the invention is to obtain a construction which has greater strength and rigidity than structures of the same general character produced before. The wheel rim *A* is of the type having a drop centre *B* bead supporting portions *C* on opposite sides and tyre retaining flanges *D*. The improved rim attaching means is formed of two elements, each of which is developed by the bending of a flat sheet metal blank, and the two elements when assembled having portions extending in three perpendicular planes. One of these elements *E* is developed from a blank having a substantially rectangular central portion and spaced pairs of flanges *F* and *G* projecting outward from opposite ends of the central portion.



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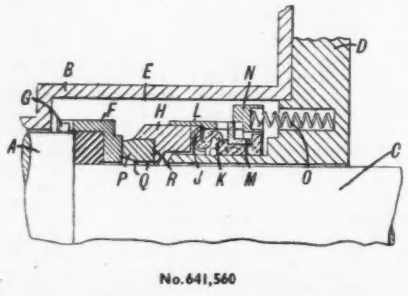
The rim has a plurality of the attachment assemblies secured to it at properly spaced points in its circumference and these form bearings for the wheel body, such as a disc *H*. Aligned apertures are formed respectively in the disc and the portion *J* of the assembly. Bolts *K* pass through these apertures. The disc body of the wheel may be placed on either side of the assembly and similarly attached at each position by the bolts *K*. However, in the one position the disc will be substantially at the centre of the rim while in the other position the rim will be laterally offset from the disc. When the disc is offset from the centre of the rim it can ride up cams *L* formed in the member *E*.—*July* 19, 1950.

MISCELLANEOUS

641,560. October 9, 1947.—Improvements relating to Means for Preventing Fluid Leakage Between Stationary and Moving Surfaces, Crane Packing, Ltd., of the Trading Estate, Slough, Buckinghamshire (*inventor, Francis Clarence Walter Wilkinson*).

According to the invention the improved sealing means consists of a ring composed essentially of a porous or capillary material, exposed on the fluid side of the sealing zone to contact with



No. 641,560

the fluid but backed on the other side with impermeable material, so that the fluid can permeate the material sufficiently to reach the opposed faces of the two sealing rings but cannot leak across the body of the porous ring. In the accompanying drawing *A* is the shaft mounted in a chamber wall *B* and having a portion *C* of reduced diameter surrounded by a cover plate *D* attached to the wall. The space *E* is occupied by the sealing means comprising the sealing ring *F* carried, as by a pin *G*, with the rotary shaft and the opposite stationary hard sealing ring *H* floating on the flanged end *J* of a resilient member *K* which exerts endwise pressure on the ring *H*. The outer wall of this ring and the forward portion of the member *K* are surrounded by a metal sleeve *L*, and the rear portion of the member is surrounded by a metal backing ring *M*. The rear end of the metal sleeve *L* abuts against a ring *N*, which is spring-urged against the sleeve by a group of coil springs *O* housed in pockets on the inner face of the cover plate *D*. The porous sealing member of the present invention is seen at *P* as a ring of substantially rectangular cross section. It is formed of powder sintered into a mass of the size and shape shown and of the desired porosity. Its inner cylindrical face *Q* and its rear end face *R* are plated or otherwise coated with metal or solder or other suitable impermeable material so that although lubricant under pressure within the space *E* can permeate the body of the ring *P* and thereby maintain lubrication at the interfaces of the rings *F* and *P*, it cannot escape across the body of the ring *P* to the non-pressure side.—*August* 16, 1950.

Personal and Business

Mr. H. A. R. Binney, C.B., has been appointed deputy director of the British Standards Institution.

Mr. C. L. G. Fairfield, A.M.I.Mech.E., A.M.I.E.E., has been appointed a director of Mullard Equipment, Ltd.

Davey, Paxman and Co., Ltd., Colchester, states that Mr. J. P. Elliott, secretary and chief accountant, has been appointed a director.

The Railway Executive states that Mr. J. W. Terry has been appointed stores superintendent in the Southern Region of British Railways.

Brook Motors, Ltd., states that its London branch has been moved to 16–18, Palmer Street, Westminster, S.W.1 (telephone, Abbey 7626).

The Steel Company of Wales, Ltd., announces the appointment of Mr. G. Smellie as works manager of the Margam, Port Talbot and Abbey Works.

Mr. G. P. Goodman, M.I.E.E., has been appointed engineer in the traction contracts branch of British Insulated Callender's Construction Company, Ltd.

Richard Thomas and Baldwins, Ltd., announces that Mr. Bryan Samain has been appointed editor of *Ingot News*, *Ingot* and other R.T.B. publications.

Mr. G. F. Cole has been appointed general manager of Clarksons (Engineers), Ltd., Nuneaton. He continues to serve as a director of the company.

Acheson Colloids, Ltd., 18, Pall Mall, London, S.W.1, has undertaken to equip a chemical research laboratory at the Plymouth and Devonport Technical College.

The Railway Executive announces the appointment of Mr. E. Morgan as assistant director of research at its headquarters, 222, Marylebone Road, London, N.W.1.

The Villiers Engineering Company, Ltd., Wolverhampton, has opened a London showroom for its two-stroke engines and freewheels at 190, Piccadilly, W.1.

Ferodo, Ltd., has opened a new depot at Ferodo House, 42, Commercial Road, Southampton (telephone, Southampton 76577). The branch manager is Mr. A. G. Power.

Mr. L. L. Goodman, B.Sc. (Eng.), A.M.I.E.E., has joined the staff of the British Electrical Development Association as technical officer dealing with industrial power matters.

Mr. W. T. Bamford, A.M.I.C.E., A.M.I.Mech.E., has been appointed group generation engineer (operation), No. 1 group of the London division, British Electricity Authority.

The English Electric Company, Ltd., states that Mr. C. R. Dawson has been appointed manager of the sales and contracts department, diesel engine division, Brownsover Hall, Rugby.

Dr. R. T. Parker, A.R.S.M., F.I.M., has been appointed director of research, Aluminium Laboratories, Ltd., Banbury. Mr. G. Forrest has been appointed associate director of research.

Mr. F. G. Andreae, a director of Quickfit and Quartz, Ltd., has retired after twenty-two years' service with the company, which is a subsidiary of the Triplex Safety Glass Company, Ltd.

The Minister of Fuel and Power has appointed Mr. D. P. Welman, M.I.Mech.E., as chairman of the North-Western Gas Board, in succession to Colonel W. M. Carr, who has resigned on account of ill-health.

Crompton Parkinson, Ltd., states that Mr. D. E. Graham, general sales manager of its overseas division, has been co-opted to the board of executive directors for a period of one year, beginning October 1st.

Automotive Products, Ltd., Leamington Spa, announces that it is building a new factory in the development area of Speke, Liverpool, for the manufacture of Lockheed aircraft components and industrial hydraulics.

The Colonial Office announces the following appointments:—Mr. J. Fielding, chief inspector of works, Public Works Department, Nigeria; and Mr. J. W. Hehu, deputy director and engineer-in-chief, Posts and Telegraphs Department, Nigeria.

The British Vacuum Cleaner and Engineering Company, Ltd., states that the address of its subsidiary, B.V.C. Industrial Constructions, Ltd., is now Terminal House, 52, Grosvenor Gardens, London, S.W.1. The parent company has also opened export showrooms at that address.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of British Chemical Manufacturers

Fri., Sept. 29th, to Sun., Oct. 1st.—Chemical Works Safety Conference at Scarborough.

British Institution of Radio Engineers

Wed., Sept. 27th.—London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1, Annual General Meeting, Presidential Address, Paul Adorian, 6.30 p.m.

Engineers Guild

Thurs., Sept. 28th.—Lighting Service Bureau, 2, Savoy Hill, London, W.C.2, Special General Meeting, 5.30 p.m.——Metropolitan Branch: Annual General Meeting, 6.15 p.m.

Illuminating Engineering Society

Thurs., Sept. 28th.—Bradford Group: Yorkshire Electricity Board, 45/53, Sunbridge Road, Bradford, "Cold Cathode Lighting Equipment," E. A. Langsdon, 7.30 p.m.

Incorporated Plant Engineers

Mon., Sept. 25th.—W. and E. Yorkshire Branch: The University, Leeds, "Deep Sea Naval Salvage," W. D. Miller, 7.30 p.m.

Fri., Sept. 29th.—Birmingham Branch: Imperial Hotel, Temple Street, Birmingham, "Oil Bound Bearings," V. T. Morgan, 7.30 p.m.

Institute of Marine Engineers

Thurs., Sept. 28th.—83, Minories, E.C.3, Presidential Address, Sir A. Murray Stephen, 5.30 p.m.

Institute of Metals

To-day, Sept. 22nd.—Forty-Second Annual Autumn Meeting at Bournemouth.

Institution of Electrical Engineers

Sat., Sept. 30th.—N. Midland Students' Section: 1, Whitehall Road, Leeds, Chairman's Address, Mr. Sykes, 2.30 p.m.

Institution of Mechanical Engineers

Sat., Sept. 23rd.—N.W. Branch, Graduates' Section: Engineers' Club, Albert Square, Manchester, "'This I have read in a book,' he said, 'and this was told to me,'" H. Wright Baker, 2.30 p.m.

Tues., Sept. 26th.—S. Wales Branch: Mackworth Hotel, Swansea, "Some Gas Producer Problems," H. F. Phillips, 6 p.m.

Wed., Sept. 27th.—Western Branch: College of Technology, Unity Street, Bristol, 1, "Rotary and Oscillating Seals," T. E. Beacham, "Reciprocating Seals," F. H. Towler, 7 p.m.——Yorkshire Branch: The University, Sheffield, "Optical Instruments Applied to Precision Measurements in Engineering," J. W. Harrison, 7 p.m.

Thurs., Sept. 28th.—N.W. Branch: Engineers' Club, Albert Square, Manchester, "The Full Application of Motion Study," Anne G. Shaw, 6.45 p.m.

Institution of Metallurgists

To-day to Sat., Sept. 30th.—Science Museum, South Kensington, London, S.W.7, Exhibition, "Metals in the Service of Mankind," weekdays, 10.0 a.m. to 6.0 p.m.; Sundays, 2.30 p.m. to 6.0 p.m.

Institution of Mining and Metallurgy

To-day to Sat., Sept. 23rd.—Conference on Wire Ropes in Mines, at Ashorne Hill, Leamington Spa, Warwickshire.

Institution of Production Engineers

Tues., Sept. 26th.—Luton, Bedford and District Section: Town Hall, Luton, Film, "Pattern for Progress," 7.15 p.m.

Wed., Sept. 27th.—Lincoln Section: Ruston and Hornsby, Ltd., Boultham Works, Lincoln, "Mechanical Handling," J. R. Sharp, 7 p.m.

Thurs., Sept. 28th.—S. Wales and Monmouthshire Section: S. Wales Institute of Engineers, Park Place, Cardiff, "Material Handling," F. T. Dean, 6.45 p.m.

Institution of Works Managers

Mon., Sept. 25th.—Leicester Branch: Franklins Gardens Hotel, Northampton, "Industrial Management and its Human and Social Implications," A. P. Young, 7 p.m.

Stephenson Locomotive Society

Sat. and Sun., Sept. 23rd and 24th.—Week-end tour of Locomotive Sheds, Midlands Area.

Sat., Sept. 30th.—N.E. Area: Visit to N.C.B. Locomotive Sheds, Ashington, 2.30 p.m.——Midlands Section: 71, Edmund Street, Birmingham, "Some Locomotives of William Dean," G. H. W. Clifford 7 p.m.